IOWA DEVELOPMENT OF RUBBLIZED CONCRETE PAVEMENT BASE MILLS COUNTY

Final Report for
Iowa Highway Research Board
Project HR-315

January 1995

Project Development Division

Iowa Department
of Transportation

Final Report
Iowa Highway Research Board
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Iowa Development of Rubblized Concrete Pavement Base Mills County

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8. ABSTRACT

Iowa counties have tried to rehabilitate deteriorating portland cement concrete (PCC) pavements with standard overlays, placement of engineering fabric, rock, open graded bituminous mixes and cracking and seating. While these methods prolong the life of the road, the cracks in the old pavement have eventually reflected to the surface. One possible alternative for rehabilitating severely deteriorated roads and preventing reflective cracking is the rubblization process.

The objective of this research project was to rehabilitate and evaluate a severely deteriorated PCC roadway using a rubblization process. A 3.0 km (1.9 mi.) section of L63 in Mills County was selected for this research. The road was divided into 16 sections. A resonate frequency vibration pavement breaker was used to rubblize the existing pavement. The variables of rubblization, drainage, and ACC overlay depths of 75 mm (3 in.), 100 mm (4 in.), and 125 mm (5 in.) were evaluated.

The research on rubblized concrete pavement bases support the following conclusions:

1. The rubblization process prevents reflective cracking.
2. Edge drains improved the structural rating of the rubblized roadway.
3. An ACC overlay of 125 mm (5 in.) on a rubblized base provided an excellent roadway regardless of soil and drainage conditions.
4. An ACC overlay of 75 mm (3 in.) on a rubblized base can provide a good roadway if the soil structure below the rubblized base is stable and well drained.
5. The Road Rater structural ratings of the rubblized test sections for this project are comparable to the nonrubblized test sections.

9. KEY WORDS	10. NO. OF PAGES
Asphalt concrete paving Asphalt overlay Break and seat Crack and seat Portland cement concrete Rehabilitation Rubblize	62

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DISCLAIMER

The contents of this report reflect the views of the author and do not necessarily reflect the official views of the Iowa Department of Transportation. This report does not constitute any standard, specification or regulation.

INTRODUCTION

Iowa counties have constructed several thousand miles of portland cement concrete (PCC) pavement over the past thirty years. Many of these pavements have deteriorated to a condition that requires rehabilitation or reconstruction. Because of the cost of total reconstruction, several alternatives are being reviewed to rehabilitate these deteriorated pavements including standard overlays, placement of engineering fabric, rock, open-graded bituminous mixes and cracking and seating. While these methods have prolonged the life of the roads, the cracks in the old pavement have eventually reflected to the surface. The most successful method to date appears to be the cracking and seating operation.

Due to budget constraints, these deteriorating PCC pavements are typically not being repaired at the most opportune time. Instead, they are rehabilitated later when a more substantial repair is required. Since this work is not being done, many of the existing pavements have deteriorated beyond the point where standard methods, including cracking and seating, would be successful. If the pavement has become severely deteriorated before the cracking and seating operation can take place, full and partial depth patching of joints, "D" cracked areas and areas of load related pavement failures is necessary. The patching process can increase the cost of the cracking and seating procedure to a point where other alternatives, including complete replacement, should be investigated.

One possible alternative for rehabilitating severely deteriorated roads is the rubblization process. With the rubblization process the existing PCC is broken into nominal

50 mm (2 in.) pieces. An asphaltic cement concrete (ACC) overlay is placed on the rubblized road. The purpose of this process is to create a dense drainable base. The base will ideally give structure to the roadway and prevent the reflective cracking from the original PCC overlay.

OBJECTIVE

The objective of this research project was to rehabilitate and evaluate a severely deteriorated PCC roadway using a rubblization process. Specific topics to be investigated include:

1. The thickness of the overlay to produce an effective roadway.
2. Any cracking pattern that may develop in the ACC overlay.
3. The structural integrity of the rubblized roadway.
4. The cost effectiveness of rubblizing.

PROJECT LOCATION AND DESCRIPTION

The project is located on Mills County road L63 (FAS route 6058) from its intersection with county road H40 to the south corporate limits of Malvern (see map, page 23).

The project is 3.0 km (1.9 mi.) in length. The original road was a 6.7 m (22 ft.) wide, 150 mm (6 in.) thick, Class B, PCC pavement with 12.2 m (40 ft.) joint spacings. The pavement was constructed with a Class 1 coarse aggregate. The pavement was severely deteriorated. Joints exhibited pop-outs and "D" cracking. The pavement structure had failed to such an extent that the pavement had shifted toward the foreslopes in some areas. Load related failure in the "Y" pattern was very apparent at the outside edges of the pavement. See photographs on page 59, Appendix E.

Average daily traffic in 1989 varied from 580 vehicles per day (vpd) near the south end of the project to 1190 vpd at the north end. Average daily traffic in 1992 varied from 410 vpd near the south end of the project to 970 vpd at the north end.

The project consisted of sixteen test sections. The test sections had nominal asphalt overlay depths of 75, 100 and 125 mm (3, 4, and 5 in.). Three of the test sections were not rubblized for use as control sections. Test sections were both drained and undrained. Table 1 on page 4 lists the test sections, their location and the variables used in each test section.

The rubblization process consists of breaking an existing PCC pavement with a resonate frequency vibration pavement breaker. Existing pavement is ideally broken into particles with a nominal size of 50 mm (2 in.). Particle size generally increases with depth since the energy for breaking the pavement is dissipated with depth. The rubblized roadway is compacted with a vibratory steel drum roller. A layer of chokestone may be placed on the compacted rubblized base. The chokestone serves as a leveling coarse to establish a final grade and to fill depressions created by the rubblization process. A vibratory steel drum roller is used to compact the chokestone. The result is a flexible interlocked stone like base that contributes to the structure of the roadway and prevents reflective cracking. An ACC overlay is placed over the rubblized base.

TABLE 1
TEST SECTIONS

TEST SECTION	STATION			ACC OVERLAY DEPTH	RUBBLIZED	SUBDRAIN
1	1+00	TO	3+50	75 mm	YES	NO
2	3+50	TO	6+00	75 mm	YES	YES
3	7+00	TO	9+50	100 mm	YES	YES
4	9+50	TO	12+00	100 mm	YES	NO
5	13+00	TO	15+50	125 mm	YES	NO
6	15+50	TO	19+00	125 mm	YES	YES
7	19+00	TO	24+00	125 mm	NO	YES
8	36+00	TO	64+70	125 mm	YES	YES
9	64+70	TO	69+00	125 mm	YES	NO
10	69+00	TO	83+00	125 mm	YES	YES
11	84+00	TO	86+50	100 mm	YES	YES
12	86+50	TO	89+00	100 mm	YES	NO
13	90+00	TO	92+50	75 mm	YES	NO
14	92+50	TO	95+00	75 mm	YES	YES
15	95+00	TO	97+50	75 mm	NO	YES
16	97+50	TO	101+01	75 mm	NO	NO

PRECONSTRUCTION

A detailed crack survey was conducted prior to construction. The crack survey was used to record distress and cracks in the ACC overlay. The crack survey was also used to identify pre-existing conditions that may have caused deterioration of the roadway after the rubblization and ACC overlay. Preconstruction average structural ratings were determined using the Iowa DOT Road Rater (Appendix C, page 32).

The project was let on May 16, 1989 with the award being made to Cessford Construction Company from LeGrand, Iowa. The total contract amount was $286,990.30. A bid of $26,471.90 was made for the rubblization portion of the contract. The remainder of the contract included application of the chokestone, ACC pavement, full depth granular shoulders, guardrail and other associated items. A copy of the contract can be found in Appendix B on page 26-28.

CONSTRUCTION

Construction of the project was done in accordance to the Standard Specifications Series of 1984 of the Iowa Department of Transportation plus the special provisions and supplemental specifications that were in effect at the time. Rubblizing of the PCC roadway was done in accordance with Special Provision 812 (Appendix B, page 29).

Rubblization of the existing PCC pavement was done with a PB4 pavement breaker manufactured by Gurries Industries (Appendix E, Photos, page 60 and 61). The PB4 is a resonant pavement breaker that transmits power through a 163 mm by 450 mm by 3.81 m (6.5 in. x 18.0 in. x 12.5 ft.) forged steel beam. The PB4 operates at a frequency of 44 impacts per second. Each impact transmits a force to the pavement of approximately 8900 N (2000 lbs.). The operating speed of the PB4 is approximately 4.0 km per hour (2.5 mph).

After rubblizing, a 50 mm to 100 mm (2 in. to 4 in.) layer of 19 mm (3/4 in.) chokestone was spread over the broken concrete (Appendix E, Photos, page 62). The chokestone acted

as a base leveling course to establish a final grade, and it filled depressions in the rubblized base. An ACC overlay was placed on the project. The overlay varied from 75 mm to 125 mm (3 in. to 5 in.) in depth. Subdrains were installed along the edge in such a manner that the drain would be in a portion of two different thicknesses of the ACC pavement. A layout of the project with the location of subdrains, ACC pavement thicknesses and rubblized and nonrubblized areas is in Appendix A, page 24.

The original asphalt mix design for the project is in Appendix D, page 41. The coarse stone was out of specification by approximately 3.5% for the minus 200 sieve. New rock was brought to the project from the same source. The Southwest Iowa Transportation Center Materials office approved a combined gradation that consisted of: 15% initial gradation stone, 45% new gradation stone and 40% sand. Proportions and production limits for the aggregates can be found in Appendix D, page 42. The design asphalt content was also lowered from 6.6% to 6.4%.

The drainage system used on the project was AdvanEDGE by Advanced Drainage Systems, Inc. A Typar geotextile wrap was placed around the panel edge drain. Typical design sections are shown in Appendix B on page 30.

DAILY CONSTRUCTION RECORD

The daily construction record is taken from the HR-315, "Iowa Development of Rubblized Concrete Pavement Base - Mills County," construction report. The construction report was written by Vaughn Bennet in March 1990.

Tuesday, September 5, 1989

The rubblizing procedure began at Station 95+00 on Tuesday, September 5, 1989 and proceeded south toward the beginning of the project (B.O.P). The entire width of the pavement was rubblized rather than just one lane at a time. The contractor began with a 225 mm (9 in.) shoe on the PB4, but was not achieving a small enough particle size. The contractor converted to a 175 mm (7 in.) shoe which provided better results. The project plan called for the PB4 to break the pavement into pieces with a nominal particle size of 50 mm (2 in.); however, the existing subbase condition made breaking the pavement into nominal 50 mm (2 in.) pieces impossible. To operate effectively the PB4 must impact against a solid surface. The soft subgrade at the project site caused the concrete to break into pieces ranging from 300 to 450 mm (12 to 18 in.). The pavement was broken into pieces ranging from 150 to 200 mm (6 to 8 in.) where the subgrade was reasonably solid. Particle sizes of 25 to 50 mm (1 to 2 in.) were obtained in areas where there was severe "D" cracking. Approximately 1692 m^2 (2022 sq. yds.) of pavement were rubblized.

Wednesday, September 6, 1989

Rubblizing continued approaching the B.O.P. Near Station 81+00 a subgrade seep area was encountered which would not allow complete rubblizing of the pavement. The subgrade was so soft that the PB4 pavement breaker fell through the broken pavement and became stuck. Additionally, while continuing to break up the old pavement in that area, the PB4 occasionally had to be pushed to prevent it from getting stuck again. An additional 5202 m^2 (6222 sq. yds.) of pavement were rubblized.

The contractor began applying the chokestone in the afternoon with a "Jersey" spreader attached to a bulldozer. The spreader was set to place stone at a depth of 50 mm (2 in.). Some of the rubblized pavement was still exposed after the application of the chokestone, but it did not appear to present any problems during the compaction procedure. However, the decision was made to remove the exposed rubblized pavement before the placement of ACC pavement. The contractor found that a better grade could be achieved by lightly blading the chokestone after it had been rolled.

Thursday, September 7, 1989

The project received approximately 38 mm (1.5 in.) of rain overnight. The rain continued intermittently until approximately 11:00 A.M. Outlets were dug in the shoulder of the road to allow the water to get out of the base. All other activities ceased until the open house demonstration at 12:30 P.M. The rubblizing continued for the remainder of the day. Approximately 7379 m^2 (8825 sq. yds.) of pavement were rubblized.

An open house was held at 10:30 A.M. with an informational meeting on rubblizing and alternate techniques of pavement repair with asphalt cement concrete pavement. At 12:30 P.M. the people in attendance were bused to the project site to observe the choking and rubblizing operations.

Friday, September 8, 1989

An extreme amount of rain was received overnight, and all operations on the project were suspended.

Discussions during the day concerning the drainage problem resulted in a decision to attempt to install the drainage structures before the placement of the ACC. It was felt that this would help to stabilize the subgrade as well as prevent any damage to the ACC pavement surface.

Monday, September 11, 1989

Approximately 3026 m^2 (3619 sq. yds.) of pavement were rubblized. This completed the rubblizing operation with a total of 17,309 m^2 (20,701 sq. yds.) of pavement being rubblized.

In the morning, the contractor began applying chokestone again in preparation for the placement of ACC pavement at a later date.

A second layer of chokestone was applied over the area near Station 81+00 to serve as a strengthening course. The chokestone that had been applied prior to the rain had developed a crust on the surface much like that on a granular surfaced road.

Tuesday, September 12, 1989

The placement of the ACC pavement was to begin, but rain overnight prevented paving operations. The remainder of the chokestone was placed. Discussions on the subdrain installation brought to light a scheduling problem so it was decided to begin ACC pavement placement on Wednesday, September 13 without the installation of the drains. The placement of the ACC pavement would begin near Station 64+00 and proceed toward the

B.O.P. The contractor would then complete the project by starting at 64+00 and proceed to the end of the project (E.O.P). This procedure would prevent loaded ACC trucks from driving over the 75 and 100 mm (3 and 4 in.) portions of the fresh pavement.

Wednesday, September 13, 1989

The ACC pavement placement was to begin, but a check of the material gradation showed that the minus 200 sieve of the coarse stone was out of specification by approximately 3.5%. Replacement material needed to be crushed in order for the project to continue.

Friday, September 15, 1989

After conferring with the Iowa DOT Southwest Iowa Transportation Center Materials Office, it was determined that an approved combined gradation could be achieved using three aggregates in the following percentages:

initial gradation rock	= 15%
new gradation rock	= 45%
sand	= 40%

The placement of the ACC pavement began as described earlier at approximately 1:15 P.M. Approximately 910 Mg (1000 tons) of mix were placed.

Monday, September 18, 1989 through Wednesday, September 20, 1989

The placement of ACC pavement was completed on Wednesday. No problems out of the ordinary were encountered.

The intended ACC pavement thickness was 88 mm (3.5 in.), but the actual thickness of the ACC pavement ranged from 79.5 to 127 mm (3.13 to 5.00 in.) with an average of 91.7 mm (3.61 in.). This may have been caused by the rough subgrade that resulted from the rubblizing. The densities ranged from 96.64% to 101.05% with an average density of 98.27%.

Saturday, September 23, 1989 through Monday, September 25, 1989

The placement of full depth shoulders was begun and completed on the entire length of the project.

Friday, September 27, 1989 through Friday, October 6, 1989

The required pavement markings and construction of guardrails on the bridge at Station 30+00 were completed.

Wednesday, October 11, 1989 through Tuesday, October 24, 1989

Work was done on the installation of shoulder drains. A problem developed when the trench was cut to place the drain tile. The saw would occasionally get caught on a piece of the rubblized concrete and pull it upward. This caused the ACC pavement to break at the edge of the roadway. After looking at the soil that came out of the trench and seeing that it would allow water to percolate through it, a decision was made to move the drain away from the edge of the ACC pavement approximately 150 mm (6 in.) to avoid damaging the pavement. Two different trenching methods were used. Initially, a large concrete wheel saw was used,

but it was this method that was causing the fraying of the ACC pavement edges as well as allowing a considerable amount of material to remain in the trench. A "Ditch Witch" type trencher was then brought to the site to complete the operation. Using this machine the contractor was able to have more control on the depth of the trench, and the contractor was able to eliminate the fraying of the ACC pavement edge. The "Ditch Witch" type trencher achieved a much cleaner trench.

Tuesday, October 24, 1989

A final inspection was conducted and project approval given.

TESTING

Testing for the project was conducted by Iowa DOT Materials personnel. Tests were conducted for both the construction and post construction stages. During the construction stages of the project, standard Iowa DOT tests were conducted for aggregate durability, aggregate gradation, density and asphalt mix design. The results of the durability tests can be found in Appendix D, page 44. Aggregate gradation test results can be found in Appendix D, pages 45 and 48-49. Asphalt concrete sample test results are in Appendix D, pages 50-52. A summary table in Appendix D on pages 46-47 lists all the known data about the asphalt samples from the plant report, cores and box samples. Copies of the daily plant reports are in Appendix D, pages 54-57. These reports have the gradation, density, voids and percent AC as measured at the ACC plant. Standard Iowa DOT testing was also conducted on the asphalt cement, but the results of the testing are not included in this report. The results of the Iowa DOT standard tests were within allowable limits. Post construction testing included coring samples, Road Rater testing, B.P.R. Roughness testing and crack surveys.

Sample Cores

Cores samples were cut as soon as possible the morning following any ACC paving. Seven samples were taken each time at random locations. The results of the coring are listed on the daily plant reports in Appendix D, pages 54-57. The seven cores from September 19, 1989 were sent to the Southwest Iowa Transportation Center as assurance samples. A copy of the assurance sample results is in Appendix D, page 53. The information obtained from the cores is listed as part of the table on pages 46-47. No correlation was found between the information obtained from the cores and the performance of the roadway.

Road Rater Summary

The Road Rater is a dynamic deflection measuring device that determines the structural rating of pavements. The Road Rater can also determine the soil K value (Westergaard's modulus of subgrade reaction) of the subbase.

Road Rater testing was conducted prior to the start of the project on August 23, 1989 (Appendix C, page 32). Road Rater testing was also conducted each year after construction during the month of March or April. A summary of the Road Rater information is in Table 2 on page 16.

A regression analysis was performed with the dependent variable being the Road Rater structural value. The independent variables were the nominal thickness of the asphalt overlay, the soil K value of the subbase from the Road Rater, rubblized or nonrubblized

pavement, drained or undrained base and the time in years since construction. A list of the input variables is given in Appendix C on pages 33-35. First, a simple one variable linear regression test was performed to determine if any of the independent variables had a significant correlation with the structural value obtained from the Road Rater. The variables of ACC depth, drainage, rubblized, and soil K value were found to be statistically significant (Appendix C, page 36). A multiple linear regression analysis was performed with these four variables with the complete data set. The result was an r^2 (sample correlation coefficient squared) value of 0.39. However, the coefficient for the depth of ACC overlay in mm was -0.0039. A negative coefficient is not logical since the structural rating is known to increase linearly with depth. Therefore, a linear regression analysis was performed without ACC depth as a variable. Linear regression analysis was also performed on only the rubblized test sections with ACC depth, drainage and soil K value as independent variables. The coefficient for ACC depth was again found to be negative, so a second linear regression was performed without ACC depth as a variable. A summary of the linear regression analysis is given in Appendix C on page 37.

The analysis is skewed because all test sections were not equally represented, and a complete matrix of possible test combinations was not built at the project site. The analysis is still capable of providing information about the significance of input variables. Drainage always provided a positive coefficient for structural rating of approximately 0.3 to 0.7. The higher end of the range represents the analysis of only rubblized test sections. Rubblizing also had positive coefficients for structural rating of approximately 0.4 to 0.5. This result was

unexpected, but might be partially explained if the existing PCC pavement panels are able to move due to the poor subgrade while Road Rater testing is being performed. The positive coefficient of soil K value was expected and supports the importance of a good base for roadway construction.

The Road Rater tests were used to back calculate the structural rating of the existing roadway and rubblized roadway. The AASHTO design coefficient of 0.44 structural numbers per 25 mm (1 in.) of asphaltic concrete were used. The structural value of the overlay was determined for each test site, and it was subtracted from the Road Rater structural rating. The resulting structural number was then divided by 150 mm (6 in.) for nonrubblized test sections and 200 mm (8 in.) for rubblized test sections. The extra 50 mm (2 in.) for the rubblized test sections is for the chokestone. The results were then divided into four subgroups based on drained or undrained and rubblized or nonrubblized. The average was calculated for each subgroup. The results are given in Appendix C on page 39. Note the rubblized and drained group is the only group to have a positive structural rating, but the structural rating for the rubblized material and chokestone is not large enough to consider in the designing of the pavement thickness.

TABLE 2

ANNUAL AVERAGE ROAD RATER VALUES

TEST SECTION	ACC OVERLAY DEPTH	RUBBLIZED	SUBDRAIN	S.R. 1990	S.R. 1991	S.R. 1992	S.R. 1993	S.R. 1994	S.R. AVG.
1	75 mm	YES	NO	*	*	*	*	*	*
2	75 mm	YES	YES	3.18	2.88	2.98	3.29	3.34	3.13
3	100 mm	YES	YES	1.64	1.66	2.07	1.65	1.63	1.73
4	100 mm	YES	NO	1.64	1.51	1.80	1.49	1.46	1.58
5	125 mm	YES	NO	*	*	*	*	*	*
6	125 mm	YES	YES	1.39	1.22	1.46	1.54	1.42	1.41
7	125 mm	NO	YES	1.65	1.60	1.90	1.83	1.75	1.75
8	125 mm	YES	YES	1.55	1.68	3.00	1.93	2.01	2.03
9	125 mm	YES	NO	1.28	1.22	1.46	1.30	1.51	1.35
10	125 mm	YES	YES	3.18	3.21	3.80	4.30	3.93	3.68
11	100 mm	YES	YES	*	*	*	*	*	*
12	100 mm	YES	NO	1.27	1.41	1.46	1.43	1.75	1.46
13	75 mm	YES	NO	0.94	1.00	0.83	0.94	0.95	0.93
14	75 mm	YES	YES	*	*	*	*	*	*
15	75 mm	NO	YES	0.92	1.15	1.06	*	*	1.04
16	75 mm	NO	NO	0.83	0.83	2.75	0.77	0.97	1.23
AVG. S.R.				1.66	1.69	2.17	1.99	1.92	1.89

Roughness Testing

B.P.R. Roughness testing was conducted on September 8, 1994. The results of the testing are in Appendix C on page 38. Road roughness indicated by this method is a comparative index expressed as inches of roughness per mile of driving lane tested. The B.P.R. Roughness value was converted into a Longitudinal Profile Value (LPV). This was accomplished by using an Iowa DOT conversion table that correlated the B.P.R. Roughness with the CHLOE Profilometer. The LPV was converted to a Present Serviceability Index (PSI). Table 3 on page 19 shows the final PSI for each test section.

The nonrubblized test sections still have high PSI values even though reflective cracking has occurred. The rubblized test sections have good ratings except for sections 1 and 2 where load failure has occurred. A reason why the rubblized sections have a lower PSI than the nonrubblized sections is that the grade of the rubblized roadway visible undulates in many areas.

Crack Survey

A detailed crack survey was conducted prior to construction in 1989. The crack survey documented cracks, joint and areas of pavement failure that might lead to reflective cracking after the rubblization process. Additional crack surveys were conducted in 1990, 1992, 1993 and 1994. The crack surveys document the occurrence of new or reflective cracks. A summary of the crack survey is presented in Table 4 on page 20.

The rubblization process prevented reflective cracking. Test section 1 and 2 (rubblized, 75 mm (3 in.) of ACC) show a large amount of cracking, but the cracking is mostly alligator cracking in the outside wheelpath. The failure is load related and not reflective. Test section 4 (rubblized, 100 mm (4 in.) of ACC) is starting to show signs of distress in year 5 of the project. The rubblized test sections on the north end of the project have fewer cracks than those in the south end. This may be due to the poor soil conditions at the south end of the project. Note that the south end of the project is where the soil was the softest during the rubblization process. Rubblized test sections with 125 mm (5 in.) of ACC have all performed well. The nonrubblized sections all have reflective cracking. The reflective cracking started during the first winter and has increased each year.

DISCUSSION

The rubblization process was an effective alternative for this project. Many of the test sections are crack free after 5 years. Because of the good performance, a cost effectiveness in terms of life cycle cost can not yet be determined. However, the process has shown itself to be a viable alternative when an existing pavement has severe failure and low structural rating numbers. The use of edge drains is encouraged in a rubblization project. If soil conditions are wet, the drains should be installed prior to rubblization. The drained soil will allow the pavement to be more effectively rubblized.

TABLE 3
PRESENT SERVICEABILITY INDEX FOR HR-315

TEST SECTION	STATION	ACC OVERLAY DEPTH	RUBBLIZED	SUBDRAIN	PRESENT SERVICEABILITY INDEX
1	1+00 TO 3+50	75 mm	YES	NO	2.12
2	3+50 TO 6+00	75 mm	YES	YES	2.29
3	7+00 TO 9+50	100 mm	YES	YES	2.65
4	9+50 TO 12+00	100 mm	YES	NO	2.64
5	13+00 TO 15+50	125 mm	YES	NO	2.66
6	15+50 TO 19+00	125 mm	YES	YES	2.63
7	19+00 TO 24+00	125 mm	NO	YES	3.64
8	36+00 TO 64+70	125 mm	YES	YES	2.84
9	64+70 TO 69+00	125 mm	YES	NO	3.17
10	69+00 TO 83+00	125 mm	YES	YES	2.80
11	84+00 TO 86+50	100 mm	YES	YES	2.82
12	86+50 TO 89+00	100 mm	YES	NO	3.17
13	90+00 TO 92+50	75 mm	YES	NO	2.84
14	92+50 TO 95+00	75 mm	YES	YES	2.82
15	95+00 TO 97+50	75 mm	NO	YES	4.69
16	97+50 TO 101+01	75 mm	NO	NO	3.83

DATE TESTED 9/8/94

TABLE 4
CRACK SURVEY SUMMARY FOR HR-315
LINEAR FEET OF CRACKS PER 100 LINEAR FEET OF ROADWAY

TEST SECTION	YEAR			
	1990	1992	1993	1994
1	8.8	8.8	8.8	209.2
2	0.0	48.0	194.0	200.0
3	0.0	0.0	0.0	5.6
4	0.0	0.0	0.0	44.8
5	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0
7	11.2	20.4	24.4	30.2
8	0.0	0.1	0.1	0.8
9	0.0	0.0	1.4	2.6
10	0.0	0.0	0.0	1.6
11	0.0	0.0	0.0	0.0
12	0.0	0.0	0.0	0.0
13	0.0	0.0	0.0	0.0
14	0.0	0.0	0.0	0.8
15	58.4	64.8	68.0	68.0
16	36.8	41.9	50.4	85.8

1.0 ft = 0.3048 m

CONCLUSIONS

This research on rubblized concrete pavement bases support the following conclusions:

1. The rubblization process prevents reflective cracking.

2. Edge drains improved the structural rating of the rubblized roadway.

3. An ACC overlay of 125 mm (5 in.) on a rubblized base provided an excellent roadway regardless of soil and drainage conditions.

4. An ACC overlay of 75 mm (3 in.) on a rubblized base can provide a good roadway if the soil structure below the rubblized base is stable and well drained.

5. The Road Rater structural ratings of the rubblized test sections for this project are comparable to the nonrubblized test sections.

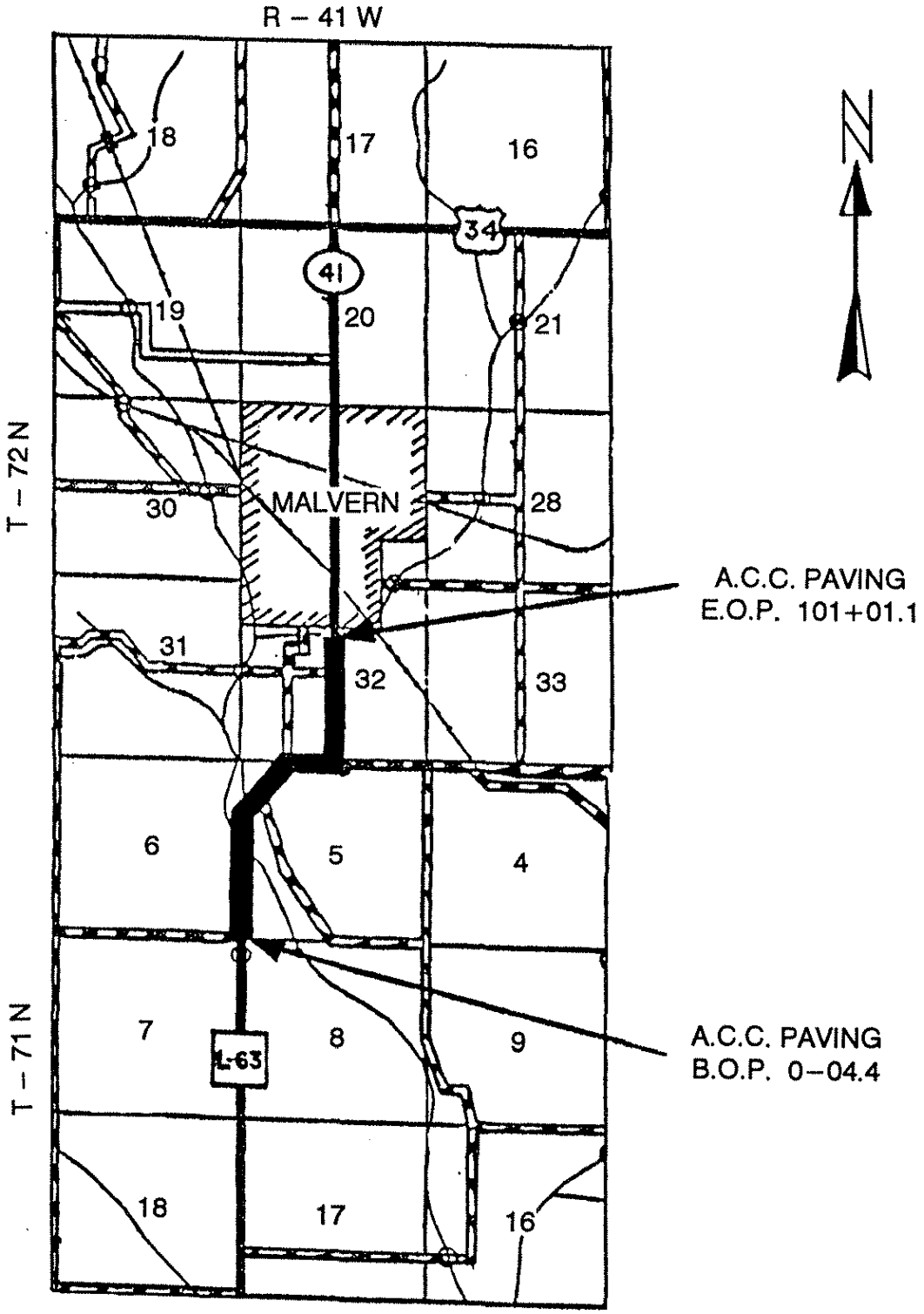
ACKNOWLEDGEMENTS

Research project HR-315 was sponsored by the Iowa Highway Research Board and Mills County. Funding for this project was from the Secondary Road Research Fund in the amount of $62,984.00. An additional $35,545.00 was placed in a contingency fund. The fund is for additional costs due to research. Mills County received approval for the reimbursement of funds from the Iowa Highway Research Board on December 8, 1994.

The authors wish to extend their appreciation to the Mills County Board of Supervisors, the Iowa Department of Transportation and the Asphalt Paving Association of Iowa for their support in developing and conducting this project. Additionally, the employees of Cessford Construction Company deserve credit and thanks for the extra effort and cooperation that was put forth in the completion of this research project.

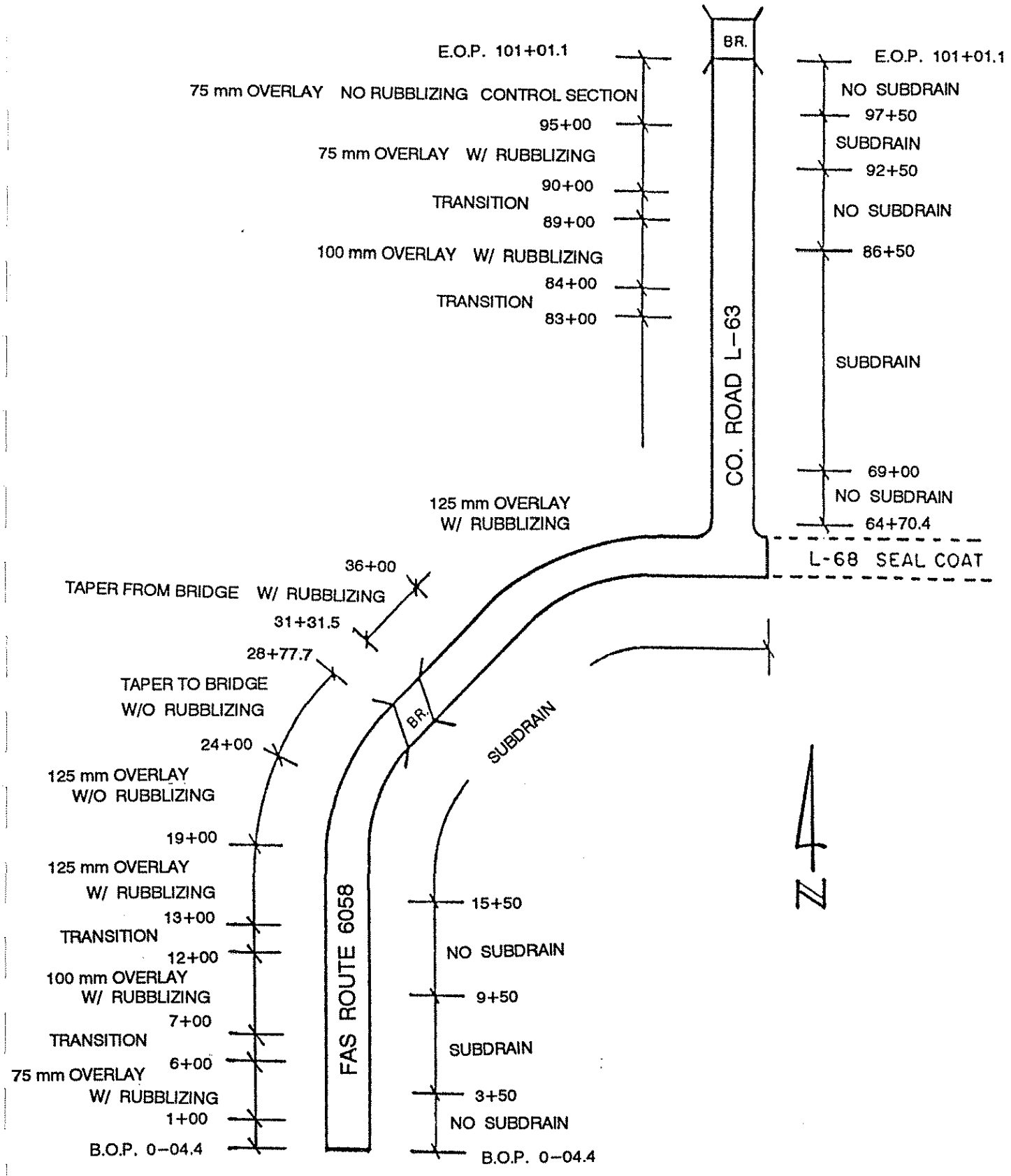
Appreciation is expressed to the Special Investigations Section of the Office of Materials for their work in obtaining test data. Appreciation is also expressed to the Research Section of the Office of Materials for their help and guidance in writing this report.

Appendix A
Maps



LOCATION MAP
NO SCALE

PROJECT LAYOUT



Appendix B
Construction Documents

Form 650019 8-87 H-688

CONTRACT NO. 30059

County MILLS Project No. SN-6058(1)--51-65
Type of Work ASPH CEMENT CONC PAVEMENT Miles 1.9140
Cost Center 801000 Object Code 860
ON SECONDARY ROAD L63 FROM THE JUNCTION SECONDARY ROAD H40 NEAR THE NW CORNER OF SECTION 8-71-41, NORTH TO THE MALVERN CITY LIMITS.

This agreement made and entered by and between the BOARD OF SUPERVISORS OF MILLS COUNTY, IOWA

Contracting Authority, and

CESSFORD CONSTRUCTION CO. OF LE GRAND, IOWA

00007350 Contractor.

It is agreed that the notice and instructions to bidders, the proposal filed herein, the general specifications of the Iowa Department of Transportation for 1984, together with supplemental specifications and special provisions, together with the general and detailed plans, if any, for said project SN-6058(1)--51-65, together with Contractor's performance bond, are made a part hereof and together with this instrument constitute the contract. This contract contains all of the terms and conditions agreed upon by the parties hereto. A true copy of said plans and specifications is now on file in the office of the Contracting Authority under date of MAY 11, 1989.

Contractor, for and in consideration of $ ****286,990.30, payable as set forth in the specifications constituting a part of this contract, agrees to construct various items of work and/or provide various materials or supplies in accordance with the plans and specifications therefor, and in the locations designated in the Notice to Bidders.

Contractor certifies by his signature on this contract, under pain of penalties for false certification, that he has complied with Iowa Code Section 324.17(8) (1985) as amended, if applicable.

In consideration of the foregoing, Contracting Authority hereby agrees to pay the Contractor promptly and according to the requirements of the specifications the amounts set forth, subject to the conditions as set forth in the specifications.

It is further understood and agreed that the above work shall be commenced or completed in accordance with the following schedule:

START. DATE	COMPL. DATE	WORK. DAYS
	10/20/89	40

Time is the essence of this contract.

To accomplish the purpose herein expressed, Contracting Authority and Contractor have signed this and four other identical instruments as of the 1st day of June, 1989.

BOARD OF SUPERVISORS OF MILLS COUNTY, IOWA

By Richard L. Simmons
Contracting Authority

Contracts Engineer JUN 5 1989
Date

CESSFORD CONSTRUCTION CO. OF LE GRAND, IOWA

By Stephen C. Knabbe
Contractor

IOWA DEPT. OF TRANSPORTATION

prm 650031 8-67 H-666

CONTRACT PRICES

Proposal I.D. No. 890791 | CONTRACT NO. 30059 | Bid Order No. 65

Contractor's No. 0,7,3,5,0 | County MILLS | Page No. 1

Project No. SN-5058(1)--51-65 | Type of Work ASPH CEMENT CONC PAVEMENT

Line No.	Item	Item Quantity and Units	Unit Price		Amount	
			Dollars X,XXX,XXX	Cents XXXX	Dollars XX,XXX,XXX	Cents XX
0010	RUBBLIZING PAVEMENT	20363 SQ. YDS.		1.3000		26,471.90
0020	ASPHALT CEMENT CONCRETE, TYPE B SURFACE COURSE, MIXT. SIZE 1/2 IN.	5765 TONS		17.2800		99,619.20
0030	ASPHALT CEMENT	339 TONS		124.8000		42,307.20
0040	SUBDRAIN, (LONGITUDINAL) AS PER PLAN	7353 LINEAR FT		2.6000		19,117.80
0050	SHOULDERS, GRANULAR, TYPE B	2087 TONS		10.1600		21,203.92
0060	SURFACING, DRIVEWAY	405 TONS		11.0500		4,475.25
0070	PAVEMENT MARKINGS, TRAFFIC STRIPE REFLECTORIZED, BROKEN LINE YELLOW	1.67 MILES		280.0000		467.60
0080	PAVEMENT MARKINGS, TRAFFIC STRIPE REFLECTORIZED, SOLID LINE YELLOW	1.65 MILES		280.0000		462.00
0090	PAVEMENT MARKINGS, TRAFFIC STRIPE REFLECTORIZED, SOLID LINE WHITE	3.83 MILES		280.0000		1,072.40
0100	GUARDRAIL, END ANCHORAGES, BEAM, RE-52	4 ONLY		360.0000		1,440.00
0110	GUARDRAIL, END ANCHORAGES, BEAM, RE-53	1 ONLY		450.0000		450.00
0120	GUARDRAIL, FORMED STEEL BEAM	181.25 LINEAR FT		7.6000		1,377.50
0130	GUARDRAIL, FORMED STEEL THRIE BEAM	637.5 LINEAR FT		12.5000		7,968.75
0140	GUARDRAIL, POSTS, BEAM	53 ONLY		41.8000		2,215.40
0150	MOBILIZATION	LUMP SUM				14,123.00
0160	BRIDGE CONNECTIONS	86 ONLY		43.0000		3,698.00
0170	PRIMER OR TACK-COAT BITUMEN	1216 GALLONS		0.6800		826.88
0180	EXCAVATION, CLASS 10, ROADWAY & BORROW	1145 CUBIC YDS		3.5000		4,007.50
0190	PAVEMENT SCARIFICATION	255 SQ. YDS.		10.2500		2,613.75
0200	SEEDING, FERTILIZING & MULCHING	1.7 ACRES		2200.0000		3,740.00
0210	SAMPLES	LUMP SUM				250.00

Form 650031 8-87 H-666

CONTRACT PRICES

Proposal I.D. No. 890791

CONTRACT NO. 30059

Bid Order No. 65

Contractor's No. 0,7,3,5,0

County MILLS

Page No. 2

Project No. SN-6058(1)--51-65

Type of Work ASPH CEMENT CONC PAVEMENT

Line No.	Item	Item Quantity and Units	Unit Price		Amount	
			Dollars X,XXX,XXX	Cents XXXX	Dollars XX,XXX,XXX	Cents
	(CONTINUED)					
0220	TRAFFIC CONTROL	LUMP SUM			2,500.	00
0230	BASE, CHOKE STONE	2645 TONS		10.0500	26,582.	50
				TOTAL	$286,990.	00

LAST PAGE

Iowa Department of Transportation

SPECIAL PROVISIONS
for
RUBBLIZING EXISTING PORTLAND
CEMENT CONCRETE PAVEMENT

Project SN-6058(1)--51-65, Mills County

May 16, 1989

812.01 DESCRIPTION. Under this item, the contractor shall rubblize and compact the existing non-reinforced portland cement concrete pavement as shown on the plans or as directed by the Engineer.

812.02 MATERIALS. All choke stone material shall meet the requirements of Article 4120.04 of the 1984 Standard Specifications with a maximum particle size of 3/4".

812.03 EQUIPMENT. The equipment required for the rubblizing process shall be a self contained, self propelled, resonant frequency pavement breaking unit capable of producing low amplitude, 2000 pound force blows at a rate of not less than 44 per second. The unit shall be equipped with a water system to suppress dust generated by the operation. A standard steel drum vibratory roller having a gross weight of not less than 10 tons operated in the vibration mode shall be used to compact the rubblized pavement.

812.04 CONSTRUCTION METHODS. A transverse joint shall be sawed full depth and load transfer devices severed on the mainline where the rubblizing abuts concrete pavement which is to remain in place. The operating speed of the rubblizing unit shall be such that the existing pavement is reduced into particles with a nominal size of 2". Continuous coverage with the breaking shoe shall be required. Additional passes of the resonator may be required if larger sizes remain after the initial rubblizing pass. Unless otherwise directed by the Engineer, the rubblizing procedure shall begin at a free shoulder edge and work to the longitudinal centerline joint.

Prior to placing the initial bituminous course, the rubblized pavement shall be compacted with 4 passes of a vibratory steel drum roller. The roller shall be operated at a speed not to exceed 6 feet per second. Any depressions in the compacted rubblized base of 1" or greater in depth from that of the surrounding area, shall be leveled using a 3/4", Class "A" crushed choke stone as specified on the plans. Additionally, the crushed choke stone will be used as needed to establish the final gradeline before the initial bituminous course is applied. The crushed choke stone shall then be compacted with the same roller and compactive effort previously described.

Reinforcement in the rubblized pavement shall be left in place. However, any reinforcement exposed at the surface as a result of rubblizing and/or compaction operations shall be cut off below the surface and removed from the site.

Except at restricted crossovers, traffic will not be allowed on the rubblized pavement before the initial bituminous base is in place. No more than 48 hours shall elapse between rubblizing pavement segments and placement of the initial bituminous course. In the event of rain, however, this time limitation may be extended to allow sufficient time for the rubblized pavement to dry to the satisfaction of the engineer.

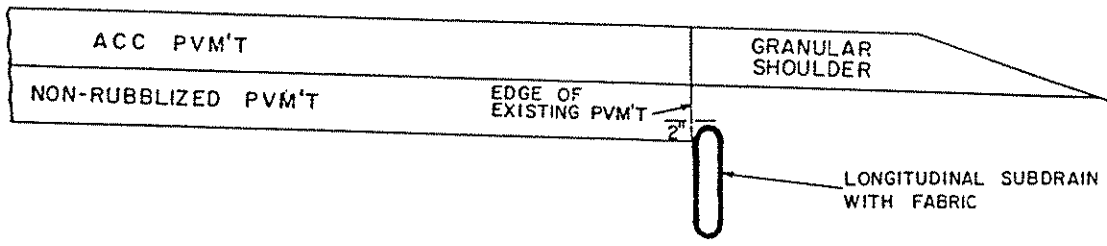
812.05 METHOD OF MEASUREMENT.

A. Rubblizing Pavement. The total area of rubblized pavement shall be measured in square yards by the Engineer.
B. Choke Stone Base. The quantity of choke stone base placed shall be measured as provided in Article 2210.11 of the 1984 Iowa Department of Transportation Standard Specifications.

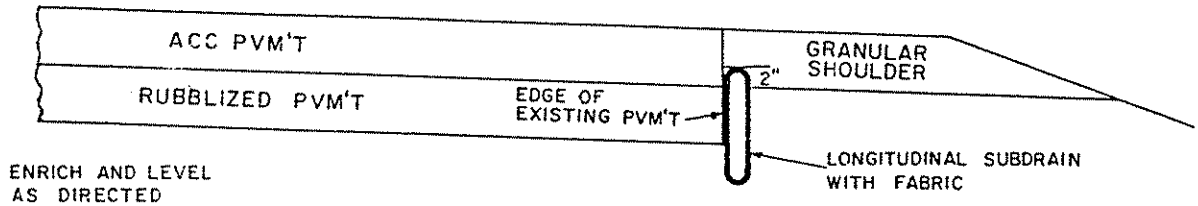
812.06 BASIS OF PAYMENT.

A. Rubblizing Pavement. For the number of square yards of pavement rubblized, the Contractor will be paid the contract price per square yard. This payment shall be full compensation for furnishing all equipment and materials, including water, and labor to rubblize the pavement, suppress dust, remove exposed reinforcement, and compact the rubblized pavement until the initial bituminous course is in place.
B. Choke Stone Base. For the number of tons of choke stone base placed, the Contractor will be paid as provided in Article 2210.12 of the 1984 Iowa Department of Transportation Standard Specifications.

SUBDRAIN TYPICAL SECTIONS



SUBDRAIN DETAIL
NON-RUBBLIZED PVM'T
(NO SCALE)



SUBDRAIN DETAIL
RUBBLIZED PVM'T
(NO SCALE)

Appendix C
Testing

PRECONSTRUCTION ROAD RATER RESULTS
HR-315 MILLS COUNTY
TESTED ON 08-23-89

MILE POST	TEST SECTION	ACC OVERLAY (mm)	DRAINAGE	RUBBLIZED	NORTHBOUND		SOUTHBOUND	
					S.R.	SOIL K	S.R.	SOIL K
0.075	2	75	YES	YES	2.42	50		
0.150	3	100	YES	YES			2.34	153
0.225	4	100	NO	YES	2.77	50		
0.300	6	125	YES	YES			2.34	50
0.375	7	125	YES	NO	2.50	50		
0.450	7	125	YES	NO			3.13	1.09
0.750	8	125	YES	YES			2.34	60
0.825	8	125	YES	YES	2.04	50		
0.900	8	125	YES	YES			2.77	112
0.975	8	125	YES	YES	2.67	50		
1.050	8	125	YES	YES			2.28	50
1.125	8	125	YES	YES	2.58	50		
1.200	8	125	YES	YES			2.58	50
1.275	9	125	NO	YES	2.42	50		
1.375	10	125	YES	YES			2.58	69
1.425	10	125	YES	YES	2.58	50		
1.500	10	125	YES	YES			2.67	92
1.650	12	100	NO	YES			2.28	50
1.725	13	75	NO	YES	2.42	50		
1.800	15	75	YES	NO			2.77	50
1.850	16	75	NO	NO	3.00	50		
1.900	16	75	NO	NO			2.50	50

VARIABLES FOR REGRESSION ANALYSIS

POINT NUMBER	TEST SECTION	MILE POST	DIR.	S.R.	DEPTH OF ACC (mm)	SOIL K VALUE	DRAINAGE (0=N, 1=Y)	RUBBLIZED (0=N, 1=Y)	YEAR*
1	2	0.075	N	3.42	75	127	1	1	1
2	3	0.150	S	1.69	100	191	1	1	1
3	4	0.225	N	1.75	100	187	0	1	1
4	6	0.300	S	1.56	125	155	1	1	1
5	7	0.375	N	1.56	125	50	1	0	1
6	7	0.450	S	1.78	125	184	1	0	1
7	8	0.750	S	1.36	125	50	1	1	1
8	8	0.825	N	1.47	125	121	1	1	1
9	8	0.900	S	1.47	125	69	1	1	1
10	8	0.975	N	1.81	125	115	1	1	1
11	8	1.050	S	1.56	125	53	1	1	1
12	8	1.125	N	1.56	125	53	1	1	1
13	8	1.200	S	1.22	125	50	1	1	1
14	9	1.275	N	1.36	125	50	0	1	1
15	10	1.375	S	2.96	125	120	1	1	1
16	10	1.425	N	3.61	125	147	1	1	1
17	10	1.500	S	2.90	125	164	1	1	1
18	12	1.650	S	1.22	100	50	0	1	1
19	13	1.725	N	0.99	75	50	0	1	1
20	15	1.800	S	0.64	75	50	1	0	1
21	16	1.850	N	0.69	75	50	0	0	1
22	16	1.900	S	1.25	75	50	0	0	1
23	2	0.075	N	2.94	75	50	1	1	1
24	3	0.150	S	1.59	100	62	1	1	1
25	4	0.225	N	1.52	100	52	0	1	1
26	6	0.300	S	1.22	125	50	1	1	1
27	7	0.375	N	1.52	125	93	1	0	1
28	7	0.450	S	1.72	125	94	1	0	1
29	8	0.750	S	1.41	125	50	1	1	1
30	8	0.825	N	1.52	125	93	1	1	1
31	8	0.900	S	1.88	125	73	1	1	1
32	8	0.975	N	1.35	125	50	1	1	1
33	8	1.050	S	2.26	125	139	1	1	1
34	8	1.125	N	1.22	125	50	1	1	1
35	8	1.200	S	1.59	125	50	1	1	1
36	9	1.275	N	1.20	125	50	0	1	1
37	10	1.375	S	2.66	125	50	1	1	1
38	10	1.425	N	3.39	125	50	1	1	1
39	10	1.500	S	3.54	125	170	1	1	1
40	12	1.650	S	1.32	100	50	0	1	1
41	13	1.725	N	0.88	75	50	0	1	1
42	15	1.800	S	1.20	75	50	1	0	1
43	16	1.850	N	0.51	75	50	0	0	1
44	16	1.900	S	0.86	75	50	0	0	1
45	2	0.075	N	2.88	75	180	1	1	2
46	3	0.150	S	1.66	100	223	1	1	2
47	4	0.225	N	1.51	100	145	0	1	2
48	6	0.300	S	1.22	125	154	1	1	2
49	7	0.375	N	1.63	125	184	1	0	2
50	7	0.450	S	1.57	125	210	1	0	2
51	8	0.750	S	1.51	125	121	1	1	2
52	8	0.825	N	1.44	125	170	1	1	2

POINT NUMBER	TEST SECTION	MILE POST	DIR.	S.R.	DEPTH OF ACC (mm)	SOIL K VALUE	DRAINAGE (0=N, 1=Y)	RUBBLIZED (0=N, 1=Y)	YEAR*
53	8	0.900	S	1.99	125	225	1	1	2
54	8	0.975	N	1.49	125	166	1	1	2
55	8	1.050	S	2.22	125	223	1	1	2
56	8	1.125	N	1.41	125	113	1	1	2
57	8	1.200	S	1.73	125	225	1	1	2
58	9	1.275	N	1.22	125	50	0	1	2
59	10	1.375	S	3.02	125	225	1	1	2
60	10	1.425	N	3.16	125	198	1	1	2
61	10	1.500	S	3.46	125	197	1	1	2
62	12	1.650	S	1.41	100	53	0	1	2
63	13	1.725	N	1.00	75	50	0	1	2
64	15	1.800	S	1.15	75	50	1	0	2
65	16	1.850	N	0.64	75	50	0	0	2
66	16	1.900	S	1.02	75	50	0	0	2
67	2	0.075	N	2.98	75	50	1	1	3
68	3	0.150	S	2.07	100	180	1	1	3
69	4	0.225	N	1.80	100	50	0	1	3
70	6	0.300	S	1.46	125	67	1	1	3
71	7	0.375	N	1.84	125	73	1	0	3
72	7	0.450	S	1.95	125	177	1	0	3
73	8	0.750	S	2.01	125	97	1	1	3
74	8	0.825	N	1.67	125	50	1	1	3
75	8	0.900	S	2.74	125	173	1	1	3
76	8	0.975	N	2.01	125	97	1	1	3
77	8	1.050	S	2.74	125	173	1	1	3
78	8	1.125	N	1.71	125	50	1	1	3
79	8	1.200	S	2.20	125	115	1	1	3
80	9	1.275	N	1.46	125	50	0	1	3
81	10	1.375	S	3.65	125	107	1	1	3
82	10	1.425	N	3.88	125	125	1	1	3
83	10	1.500	S	3.88	125	185	1	1	3
84	12	1.650	S	1.46	100	50	0	1	3
85	13	1.725	N	0.83	75	50	0	1	3
86	15	1.800	S	1.06	75	50	1	0	3
87	16	1.850	N	4.42	75	225	0	0	3
88	16	1.900	S	1.07	75	50	0	0	3
89	2	0.075	S	3.29	75	132	1	1	4
90	3	0.150	N	1.65	100	130	1	1	4
91	4	0.225	S	1.49	100	50	0	1	4
92	6	0.300	N	1.54	125	110	1	1	4
93	7	0.375	S	2.06	125	71	1	0	4
94	7	0.450	N	1.59	125	117	1	0	4
95	8	0.750	N	1.98	125	139	1	1	4
96	8	0.825	S	2.13	125	195	1	1	4
97	8	0.900	N	2.27	125	216	1	1	4
98	8	0.975	S	1.62	125	110	1	1	4
99	8	1.050	N	1.74	125	163	1	1	4
100	8	1.125	S	1.65	125	83	1	1	4
101	8	1.200	N	2.11	125	174	1	1	4
102	9	1.275	S	1.30	125	50	0	1	4
103	10	1.375	N	4.43	125	186	1	1	4
104	10	1.425	S	3.93	125	168	1	1	4
105	10	1.500	N	4.53	125	199	1	1	4

POINT NUMBER	TEST SECTION	MILE POST	DIR.	S.R.	DEPTH OF ACC (mm)	SOIL K VALUE	DRAINAGE (0=N, 1=Y)	RUBBLIZED (0=N, 1=Y)	YEAR*
106	12	1.650	N	1.43	100	50	0	1	4
107	13	1.725	S	0.94	75	50	0	1	4
108	16	1.850	S	0.58	75	50	0	0	4
109	16	1.900	N	0.95	75	50	0	0	4
110	2	0.750	N	3.34	75	171	1	1	5
111	3	0.150	N	1.14	100	105	1	1	5
112	3	0.150	S	2.11	100	190	1	1	5
113	4	0.225	N	1.46	100	123	0	1	5
114	6	0.300	N	1.30	125	110	1	1	5
115	6	0.300	S	1.54	125	225	1	1	5
116	7	0.375	N	1.80	125	225	1	0	5
117	7	0.450	S	1.70	125	225	1	0	5
118	8	0.750	S	1.90	125	209	1	1	5
119	8	0.825	N	2.48	125	225	1	1	5
120	8	0.900	S	2.46	125	225	1	1	5
121	8	0.975	N	2.01	125	163	1	1	5
122	8	1.050	S	1.60	125	198	1	1	5
123	8	1.125	N	1.63	125	167	1	1	5
124	8	1.200	S	1.98	125	181	1	1	5
125	9	1.275	N	1.51	125	153	0	1	5
126	10	1.375	S	4.13	125	225	1	1	5
127	10	1.425	N	4.07	125	225	1	1	5
128	10	1.500	S	3.59	125	225	1	1	5
129	12	1.650	S	1.57	100	69	0	1	5
130	13	1.725	N	0.95	75	50	0	1	5
131	15	1.800	S	0.37	75	50	1	0	5
132	16	1.850	N	0.86	75	50	0	0	5
133	16	1.900	S	1.07	75	60	0	0	5

* 1='90, 2='91, 3='92, 4='93, 5='94

ONE VARRIABLE LINEAR REGRESSION FOR HR-315
ALL REGRESSION USES THE STRUCTURAL RATING AS THE DEPENDENT VARIABLE

DEPTH OF ACC Regression Output:		
Constant		0.401303
Std Err of Y Est		0.873996
R Squared		0.093591
No. of Observations		133
Degrees of Freedom		131
X Coefficient(s)	0.013521	
Std Err of Coef.	0.003676	

SOIL K VALUE Regression Output:		
Constant		0.980689
Std Err of Y Est		0.761029
R Squared		0.312761
No. of Observations		133
Degrees of Freedom		131
X Coefficient(s)	0.007872	
Std Err of Coef.	0.001019	

DRAINAGE Regression Output:		
Constant		1.263888
Std Err of Y Est		0.832038
R Squared		0.178530
No. of Observations		133
Degrees of Freedom		131
X Coefficient(s)	0.866420	
Std Err of Coef.	0.162379	

RUBBLIZED Regression Output:		
Constant		1.346896
Std Err of Y Est		0.870315
R Squared		0.101210
No. of Observations		133
Degrees of Freedom		131
X Coefficient(s)	0.701949	
Std Err of Coef.	0.182762	

YEAR Regression Output:		
Constant		1.668980
Std Err of Y Est		0.909041
R Squared		0.019445
No. of Observations		133
Degrees of Freedom		131
X Coefficient(s)	0.084261	
Std Err of Coef.	0.052278	

IF THE COMPUTED R EXCEEDS THE CRITICAL VALUE 0.222, IT IS REJECTED THAT AT A 1% LEVEL OF SIGNIFICANCE THE NULL HYPOTHESIS THAT THE POPULATION HAS ZERO CORRELATION WITH THE STRUCTURAL RATING.

0.222 SQUARED = 0.049284

THUS ANY R SQUARED VALUE GREATER THAN 0.049284 REJECTS THE NULL HYPOTHESIS AND IS CONSIDERED STATISTICALLY SIGNIFICANT.

DEPTH OF ACC, SOIL K, DRAINAGE, AND RUBBLIZING ALL ARE STATISTICALLY SIGNIFICANT.

REFERENCE

STATISTICS MANUAL;EDWIN L CROW, FRANCES A. DAVIS, MARGARET W. MAXIFIELD

MULTIVARIABLE LINEAR REGRESSION ANALYSIS

ALL TEST SECTIONS

Regression Output:

Constant	0.853684
Std Err of Y Est	0.723311
R Squared	0.393412
No. of Observations	133
Degrees of Freedom	128

	Depth ACC	Soil K	Drainage	Rubblized
X Coefficient(s)	−0.00390	0.006327	0.460010	0.515267
Std Err of Coef.	0.003966	0.001115	0.179447	0.164661

RUBBLIZED TEST SECTIONS ONLY

Regression Output:

Constant	1.498318
Std Err of Y Est	0.749286
R Squared	0.323803
No. of Observations	104
Degrees of Freedom	100

	Depth ACC	Soil K	Drainage
X Coefficient(s)	−0.00554	0.005468	0.672401
Std Err of Coef.	0.004841	0.001315	0.215458

ALL TEST SECTIONS

Regression Output:

Constant	0.544151
Std Err of Y Est	0.723227
R Squared	0.388814
No. of Observations	133
Degrees of Freedom	129

	Soil K	Drainage	Rubblized
X Coefficient(s)	0.006143	0.379964	0.460929
Std Err of Coef.	0.001099	0.159975	0.155128

RUBBLIZED TEST SECTIONS ONLY

Regression Output:

Constant	0.950829
Std Err of Y Est	0.750437
R Squared	0.314941
No. of Observations	104
Degrees of Freedom	101

	Soil K	Drainage
X Coefficient(s)	0.005367	0.573822
Std Err of Coef.	0.001314	0.197808

HR 315
MILLS COUNTY
ROUGHOMETER

Test Section	North Bound		South Bound		Section Roughness (in/mile)	Longitudinal Profile Value*	Alligator Cracking (ft^2)	Present Serviceability Index#
	Revolutions	Roughness (in)	Revolutions	Roughness (in)				
1	36	8	38	9				
1	38	8	36	7	160	2.21	500	2.12
1	36	7	36	8				
2	35	7	35	7				
2	35	6	35	7	142	2.39	600	2.29
2	34	6	37	7				
3	36	5	36	6				
3	37	5	35	6	119	2.65	0	2.65
3	36	5	35	7				
4	36	5	36	7				
4	36	5	35	6	118	2.64	0	2.64
4	36	5	37	6				
5	36	6	36	5				
5	35	6	36	5	120	2.66	0	2.66
5	34	6	35	6				
6	48	7	49	8				
6	50	7	47	8	117	2.63	0	2.63
6	51	8	49	8				
7	71	9	74	4				
7	77	10	72	7	79	3.64	0	3.64
7	71	9	74	7				
8	368	62	371	48				
8	369	56	376	50	109	2.84	0	2.84
8	370	57	372	50				
9	55	5	57	8				
9	56	6	56	9	93	3.17	0	3.17
9	58	6	55	8				
10	197	31	198	27				
10	199	32	200	27	111	2.80	0	2.80
10	200	33	199	27				
11	36	6	37	5				
11	33	5	35	5	110	2.82	0	2.82
11	36	6	35	4				
12	36	5	35	4				
12	37	4	36	5	98	3.17	0	3.17
12	35	4	36	6				
13	37	6	35	5				
13	37	6	36	5	109	2.84	0	2.84
13	37	5	38	5				
14	35	6	36	5				
14	34	5	34	5	110	2.82	0	2.82
14	37	5	36	5				
15	38	3	35	3				
15	35	3	37	4	65	4.69	0	4.69
15	38	3	36	3				
16	35	3	35	4				
16	36	3	35	4	75	3.83	0	3.83
16	35	3	34	4				

1 in./mile = 15.8 mm/km

Date Tested 9/8/94
* From BPR Roughness and LPV Correlation Table Dated 06/27/91
# Calculated by Test Method No. Iowa 1004–D, September 1991

BACK CALCULATION OF STRUCTURAL RATING VALUES FOR ORIGINAL PAVEMENT

RUBBLIZED	
DRAINED	0.022 SR per inch
UNDRAINED	−0.055 SR per inch

NONRUBBLIZED	
DRAINED	−0.077 SR per inch
UNDRAINED	−0.027 SR per inch

ASSUMPTIONS:
BASED ON NOMINAL ACC PAVEMENT THICKNESSES
ACC SR VALUE OF 0.44 PER INCH
RUBBLIZED HAD 6 INCH PAVEMENT AND 2 INCHES OF CHOKESTONE
NONRUBBLIZED HAD 6 INCH PAVEMENT

Appendix D
Material Testing

A8D9-4001
8D

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
TEST REPORT - ASPHALT MIX DESIGN
LAB LOCATION - AMES

LAB NO....:A8D9-4001

MATERIAL.....:TYPE B
INTENDED USE....:SURFACE
PROJECT NO.....:SN-6058(1)--51-65
COUNTY.....:MILLS — CONTRACTOR:CESSFORD
SPEC NO.....:1070.00 — SIZE.....:1/2
SAMPLED BY.....: — SENDER NO.:
DATE SAMPLED: — DATE RECEIVED: — DATE REPORTED: 08/16/89
PROJ. LOCATION: ON L63 FROM L40 NORTH TO MALVERN

AGG SOURCES: 1/2 CR. LSTONE-SCHILDBERG, SILVER CITY;
POTTAWATTAMIE CO; SAND- HALLETT, OAKLAND, POTTAWATTAMIE CO.
P.I.: NOT TESTED

JOB MIX FORMULA-COMB. GRADATION

1 1/2"	1"	3/4"	1/2"	3/8"	NO.4	NO.8	NO.16	NO.30	NO.50	NO.100	NO.200
	100.0	99.0	90.0	70.0	52.0	36.0	22.0	11.0	6.8		5.7

TOLERANCE /100 :

	92	7	7	6	5	3

MATERIAL MIX	A78004	A78504			
% AGGR. PROP.	60.00	40.00	0.00	0.00	0.00

ASPHALT SOURCE AND	KOCH			
APPROXIMATE VISCOSITY POISES	1094			
% ASPHALT IN MIX	5.00	6.00	7.00	0.00
NUMBER OF MARSHALL BLOWS	50	50	50	0
MARSHALL STABILITY - LBS.	2577	2377	2373	0
FLOW - 0.01 IN.	8	11	13	0
SP GR BY DISPLACEMENT (LAB DENS)	2.238	2.276	2.315	0.000
BULK SP. GR. COMB. DRY AGG.	2.613	2.613	2.613	0.000
SP. GR. ASPH. @ 77 F.	1.031	1.031	1.031	0.000
CALC. SOLID SP. GR.	2.438	2.404	2.370	0.000
% VOIDS - CALC.	8.21	5.31	2.33	0.00
RICE SP.GR.	2.422	2.395	2.362	0.000
% VOIDS - RICE	7.60	4.97	1.99	0.00
% WATER ABSORPTION - AGGREGATE	0.42	0.42	0.42	0.00
% VOIDS IN MINERAL AGGREGATE	18.63	13.12	17.61	0.00
% V.M.A. FILLED WITH ASPHALT	55.92	70.68	86.78	0.00
CALC. ASPH. FILM THICK. MICRONS	8.37	10.11	11.86	0.00
FILLER/BITUMEN RATIO	0.00	0.86	0.00	0.00
TEMP=	210			
WT=	7100			
SLOPE=	4.96			
INTER=	-5.40			

A CONTENT OF 6.6% ASPHALT IS RECOMMENDED TO START THE JOB.
TOLERANCE ON #200 ALSO CONTROLLED BY FILLER/BITUMEN RATIO.
COPIES TO:
CENTRAL LAB — CESSFORD — D. HEINS
W. OPPEDAL — R. MONROE — MILLS CO.
DIST. 4

FORM 955

IOWA DEPARTMENT OF TRANSPORTATION
HIGHWAY DIVISION
OFFICE OF MATERIALS
PROPORTIONS & PRODUCTION LIMITS FOR AGGREGATES

COUNTY: MILLS PROJECT NO.: SN-6058(1)--51-55 DATE: 08/09/89

PROJECT LOCATION: ON L63 FROM L40 NORTH TO MALVERN

TYPE OF MIX: B CLASS OF MIX: COURSE: SURFACE MIX SIZE: 1/2"

CONTRACTOR: CESSFORD CONSTR. CO. TRAFFIC: N/A A.D.T.

MATERIAL	IDENT #	% IN MIX	PRODUCER & LOCATION
1/2" STONE	4MD9-50	60	SCHILDBERG SILVER CITY A78004
CONC. SAND	4MD9-51	40	HALLETT MATLS. OAKLAND A78504

TYPE AND SOURCE OF ASPHALT CEMENT: KOCH AC-10

GRADATION OF INDIVIDUAL AGGREGATE SAMPLES (Typical, Target, or Average)

MATERIAL	SIEVE ANALYSIS -% PASSING 1-1/2	1	3/4	1/2	3/8	4	8	16	30	50	100	200
1/2" STONE	100	100	100	98	83	52	33	23	18	14	11	9.3
CONC. SAND	100	100	100	100	100	96	81	56	29	6.3	0.6	0.3

PRELIMINARY JOB MIX FORMULA TARGET GRADATION

TOLERANCE				3[illegible]	7	7	6		5			3
COMB GRADING	100	100	100	99	90	70	52	36	22	11	6.8	5.7
SURFACE AREA C.		TOTAL				0.02	0.04	0.08	0.14	0.30	0.60	1.60
S.A. SQ. FT./LB.		28.02			+2.0	1.4	2.1	2.9	3.1	3.3	4.1	9.1

PRODUCTION LIMITS FOR AGGREGATES APPROVED BY THE CONTRACTOR/PRODUCER

SIEVE SIZE	60.0% 1/2" STONE MIN	MAX	40.0% CONC. SAND MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX
1	100.0	100.0	100.0	100.0						
3/4	100.0	100.0	100.0	100.0						
1/2	96.0	100.0	100.0	100.0						
3/8	76.0	86.0	100.0	100.0						
#4	46.0	56.0	90.0	100.0						
#8	25.0	35.0	84.0	96.0						
#30	10.0	23.0	24.0	34.0						
#200	6.0	9.5	0.0	1.5						

COMMENTS: AMES, SAMSON, MILLS CO., CESSFORD, GEARHART, WARM, JOHNSON, SCHILDBERG, HALLETT, ATL. LAB., FILE

The above data is furnished for informational purposes only. The Contracting Authority makes no representations as to accuracy, either express or implied, which are to be construed to relieve the Contractor from the responsibility to comply with the specifications.

Signed Theodore Huisman
Contractor/Producer

Signed Glen E. Miller by TDJ
Dist. Matls. Engr.

Form 370-820908
10-85

Iowa Department of Transportation

Materials Department
Ames, Iowa

REPORT OF FIELD CHANGES IN ASPHALTIC CONTRETE MIX PROPORTIONS

County Mills Project No. SN-6058(1)--51-65

Project Engineer Mills Co. Mix Number ABD9-4001

Date 9-19-89 Contractor Cessford Const.

Type Mix B Class I Mix Size 1/2"

Basic A.C. % _____ Lab. Recommend A.C. % _____

For reasons listed below the field intended asphalt content was changed from _____% to _____%.

Lab. Voids % before change _____ Lab. Voids % after change _____

Stability before change _____ Stability after change _____

For reasons listed below the (aggregate proportions - target gradation) were adjusted as follows:

Sand was finer than original sample

Job Mix Formula

SIEVE SIZE	TOL. *%*	ORIG. % P.	REV. % P.
¾"	±	100	100
½"	± 92 100	99	99
⅜"	± 7	90	90
#4	± 7	70	70
#8	± 6	52	52
#30	± 5	22	25
#200	± 3	5.7	5.7

Klen E. Miller
District Materials Engineer

AAT9-0977 ASSURANCE

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
TEST REPORT - BITUMINOUS AGGREGATES
LAB LOCATION - AMES

LAB NO....:AAT9-0977

MATERIAL........:+4 CRUSHED LIMESTONE
INTENDED USE....:SURFACE
PRODUCER........:SCHILDBERG CONST CO INC
PROJECT NO......:SN-6058(1)--51-65 CONTRACT #:30059
COUNTY..........:MILLS QUARRY NO.:A78004
SPEC NO.........:4126.90 CONTRACTOR:CESSFORD CONSTR.
SOURCE..........:SILVER CITY SE-31-074N-41W, POTTAWATTAMIE
UNIT OF MATERIAL:1 - BAG FROM STOCKPILE AT PLANT
SAMPLED BY......:JOHNSON SENDER NO.:4FJ90095
DATE SAMPLED: 09/18/89 DATE RECEIVED: 09/20/89 DATE REPORTED: 09/27/89

LAB NUMBER	AAT9-0977
TYPE OF AGGREGATE	STONE
SPEC NUMBER CLASS	1
AFTER 16 CYCLES, F&T METHOD A % LOSS	23
AFTER 25 CYCLES, F&T METHOD C % LOSS	6
LA ABRASION % LOSS, GRADING B	28

COPIES TO:
CENTRAL LAB GEOLOGYF DIST.1

DISPOSITION: COMPLIES WITH CURRENT SPECS.

Form 821283
7-85

Iowa Department of Transportation

ADVISORY GRADATION TEST REPORT

County Mills
Project SN-6058(1)--51-65
Contract No. 30059
Design
Date 11-21-89

☒ Assuance Sample
☐ Monitor Sample

Plant Location Malvern Source Location Sec. TWP Range County
Material Combined Agg. Material Producer Beds
Contractor Cessford Constr. Destination A. C. Plant
Tested By Wahlert at Lab. 9-19, 1989 Sampled By Johnson at Plant 9-18, 1989

Lab No. Grad. No.	Identification of Samples		Sieve Analysis —in.	1 in.	¾ in.	½ in.	⅜ in.	No. 4	No. 8	No. 16	Percent Passing No. 30	No. 50	No. 100	No. 200	Percentage Objectionable Substances 1 Shale Non Carb.	2 Coal +Carb Shale	3 Shale +No. 2	4 Clay Lumps	5 Sticks	No. Tons
*Production Limits		Max.				100	97	77	58		30			8.7						
		Min.				92	83	63	46		20			2.7						
	4FJ9-97					100	88	70	53	40	26	12	7.2	6.3						
					100	98	89	70	54	42	28	13	7.7	6.7						
*Production Limits		Max.																		
		Min.																		

Note to County and Resident Engineers—If County or Project Number is incorrect, please notify Inspector and Ames Office Promptly. Corrected Reports will be Issued.

Copies to: contractor, producer, Distr. Engr., Proj. Engr., Ames, As Listed.
Ames
Samson
Mills Co.
Comments File

*APPROVED by the contractor/producer

(Check One)
ESTIMATED QUANTITY ☐ Cu. Yd. ☐ Tons
TOTAL PREVIOUSLY REPORTED ☐ Cu. Yd. ☐ Tons
TOTAL REPORTED TO DATE ☐ Cu. Yd. ☐ Tons

Signed Glen E. Miller

45

ACC TEST RESULTS

Sample Type	Date Sampled	% AC By Extraction	% AC By Nuclear	% AC By Tank Measure	Marshall Stability (lbs)	Specific Gravity	Lab Density	Specific Gravity High Pressure Meter	% Voids
Assurance	9/18/89	6.16	6.86		2188		2.295		
Box	9/15/94	6.38	6.82			2.39	2.290	3.362	3.00
Box	9/18/89		6.86			2.39	2.289	2.365	3.10
Box	9/19/89		6.51			2.39	2.295	2.375	3.30
Box	9/20/89		6.96			2.39	2.291	3.372	3.50
Core	9/19/89						2.216		
Core	9/19/89						2.291		
Core	9/19/89						2.232		
Core	9/19/89						2.249		
Core	9/19/89						2.245		
Core	9/19/89						2.267		
Core	9/19/89						2.229		
Plant Report	9/15/89			6.48			2.236		5.33
Plant Report	9/15/89			6.48			2.262		4.23
Plant Report	9/15/89			6.48			2.242		5.08
Plant Report	9/15/89			6.48			2.255		4.53
Plant Report	9/15/89			6.48			2.272		3.81
Plant Report	9/15/89			6.48			2.262		4.23
Plant Report	9/15/89			6.48			2.314		2.03
Plant Report	9/18/89			6.25			2.235		5.50
Plant Report	9/18/89			6.25			2.212		6.47
Plant Report	9/18/89			6.25			2.251		4.82
Plant Report	9/18/89			6.25			2.231		5.66
Plant Report	9/18/89			6.25			2.268		4.10
Plant Report	9/18/89			6.25			2.269		4.06
Plant Report	9/18/89			6.25			2.223		6.00
Plant Report	9/19/89			6.33			2.219		6.57
Plant Report	9/19/89			6.33			2.291		3.54
Plant Report	9/19/89			6.33			2.231		6.06
Plant Report	9/19/89			6.33			2.256		5.01

ACC TEST RESULTS

Sample Type	Date Sampled	% AC By Extraction	% AC By Nuclear	% AC By Tank Measure	Marshall Stability (lbs)	Specific Gravity	Lab Density	Specific Gravity High Pressure Meter	% Voids
Plant Report	9/19/89			6.33			2.250		5.26
Plant Report	9/19/89			6.33			2.270		4.42
Plant Report	9/19/89			6.33			2.230		6.11
Plant Report	9/20/89			6.52			2.249		5.14
Plant Report	9/20/89			6.52			2.173		8.43
Plant Report	9/20/89			6.52			2.218		6.49
Plant Report	9/20/89			6.52			2.194		7.50
Plant Report	9/20/89			6.52			2.230		5.99
Plant Report	9/20/89			6.52			2.215		6.62
Plant Report	9/20/89			6.52			2.202		7.17

Form 820257
6-83

ASPH. CONC.
DISTRICT NO. 4
CO. NO. 65

Iowa Department of Transportation

Materials Department

AMES LABORATORY

FORM 257
20M 4-71

ASSURANCE SAMPLE

TEST REPORT — BITUMINOUS MATERIALS

Material: Uncompacted Mix 6.4% A.C. Laboratory No.: ABC9-309

Intended Use: Surface Contract No.: 30059

Project No.: SN-6058(1)--51-65 County: Mills

Contractor: Cessford Construction

Producer:

Plant:

Unit of Material: 1-box from project

Sampled by: Johnson Sender's No.: 4FJ9-96

Date Sampled: 9/18/89 Date Rec'd: 9/25/89 Date Reported: 10/3/89

SIEVE ANALYSIS — PER CENT PASSING

	1½"	1"	3/4"	1/2"	3/8"	No. 4	No.8	No. 16	No. 30	No. 50	No. 100	No. 200
			100	99	89	70	54	40	27	12	7.6	6.6
COLD FEED GRAD.			100	88	70	53	40	26	12	7.2	6.3	

% Aggregate - By Extraction	93.84
% Bitumen - By Extraction	6.16
% Water	
% Volatile	
Specimens molded & tested @ 77° F.	
Marshall Stability, lbs.	2188
Flow, 0.01 Inches	9
Specific Gravity	2.295
After 8 cycles of F&T Specimens molded @ 40° F. & tested @ 77° F.	
Marshall Stability, lbs.	
Flow, 0.01 Inches	
Specific Gravity	
Percent AC Intended	6.4
Percent AC Central Lab (Nuclear)	6.96
Percent AC District 4 Lab (Nuclear)	6.86

DISPOSITION:

48 By Chris V. Lane

4BC9-0219 PROJECT INFO
BC

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
TEST REPORT - ASPHALT CONCRETE
LAB LOCATION - DISTRICT 4

LAB NO....:4BC9-0219

MATERIAL.....:1/2 TYPE B
INTENDED USE....:SURFACE
PROJECT NO.....:SN-6058(1)--51-65
COUNTY.....:MILLS CONTRACTOR:CESSFORD
SAMPLED BY.....: SENDER NO.:HM1A
DATE SAMPLED: 09/15/89 DATE RECEIVED: 09/15/89 DATE REPORTED: 09/20/8

SIEVE ANALYSIS PERCENT PASSING

SIEVE	GRAM RETAINED	PERCENT RETAINED	PERCENT PASSING	TARGET GRADATION	SPEC LOW LIMIT	SPEC HIGH LIMIT
3/4		10.00		1.001	0.0	
1/2	0.1	0.00		92.100		
3/8	8.8		0.08	309.700		
4	680.0		6.30	770.000		0.5
8	1000.0	0.00	460.58			38.0
16					0.2	500.0
30		17.02	700.00		11.0	
50				0.000	610.0	
100				0.051		0.0
200	2708.7					

ASPHALT CONCRETE RESULTS

% AC IN MIX BY NUCLEAR GAUGE	6.820
% AC INTENDED	6.400
% AGGREGATE BY EXTRACTION	6.380
% BITUMEN BY EXTRACTION	93.620
SPECIFIC GRAVITY	2.390
LAB DENSITY (50 BLOW-MARSHALL)	2.290
SPECIFIC GRAVITY RICE METHOD	2.361
SPECIFIC GRAVITY HIGH PRESSURE METER	2.362
% VOIDS (50 BLOW-MARSHALL-RICE)	3.00

COPIES TO:
CENTRAL LAB DIST. 4

4BC9-0224 PROJECT INFO

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
TEST REPORT - ASPHALT CONCRETE
LAB LOCATION - DISTRICT 4

LAB NO....:4BC9-0224

MATERIAL.....:1/2" TYPE B CLASS I
INTENDED USE....:SURFACE
PROJECT NO.....:SN-6058(1)--51-65
COUNTY.....:MILLS CONTRACTOR:CESSFORD
SAMPLED BY.....: SENDER NO.:HM2A
DATE SAMPLED: 09/18/89 DATE RECEIVED: 09/18/89 DATE REPORTED: 09/18/89

SIEVE ANALYSIS PERCENT PASSING

SIEVE	GRAM RETAINED	PERCENT RETAINED	PERCENT PASSING	TARGET GRADATION	SPEC LOW LIMIT	SPEC HIGH LIMIT
ASPHALT CONCRETE RESULTS						
% AC IN MIX BY NUCLEAR GAUGE				6.860		
% AC INTENDED				6.400		
SPECIFIC GRAVITY				2.390		
LAB DENSITY (50 BLOW-MARSHALL)				2.289		
SPECIFIC GRAVITY HIGH PRESSURE METER				2.365		
VOIDS (50 BLOW-MARSHALL-RICE)				3.10		

CC: MILLS COUNTY ENGINEER
COPIES TO:
CENTRAL LAB DIST. 4

4BC9-0226 PROJECT INFO
BC

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
TEST REPORT - ASPHALT CONCRETE
LAB LOCATION - DISTRICT 4

LAB NO....:4BC9-0226
MATERIAL.....:1/2" TYPE B CLASS I
INTENDED USE....:SURFACE
PROJECT NO.....:SN-6058(1)--51-65
COUNTY.....:MILLS CONTRACTOR:CESSFORD
SAMPLED BY.....: SENDER NO.:HM3A
DATE SAMPLED: 09/19/89 DATE RECEIVED: 09/19/89 DATE REPORTED: 09/19/89

SIEVE	SIEVE ANALYSIS PERCENT PASSING GRAM RETAINED	PERCENT RETAINED	PERCENT PASSING	TARGET GRADATION	SPEC LOW LIMIT	SPEC HIGH LIMIT

ASPHALT CONCRETE RESULTS

% AC IN MIX BY NUCLEAR GAUGE	6.510
% AC INTENDED	6.400
SPECIFIC GRAVITY	2.390
LAB DENSITY (50 BLOW-MARSHALL)	2.295
SPECIFIC GRAVITY HIGH PRESSURE METER	2.375
% VOIDS (50 BLOW-MARSHALL-RICE)	3.30

CC: MILLS COUNTY ENGINEER
COPIES TO:
CENTRAL LAB DIST. 4

4BC9-0230 PROJECT INFO
RC

IOWA DEPARTMENT OF TRANSPORTATION
OFFICE OF MATERIALS
TEST REPORT - ASPHALT CONCRETE
LAB LOCATION - DISTRICT 4

LAB NO....:4BC9-0230

MATERIAL.....:1/2 TYPE B
INTENDED USE....:SURFACE
PROJECT NO.....:SN-6058(1)--51-65
COUNTY.....:MILLS CONTRACTOR:CESSFORD
SAMPLED BY.....: SENDER NO.:HM4A
DATE SAMPLED: 09/20/89 DATE RECEIVED: 09/20/89 DATE REPORTED: 09/21/89

SIEVE	SIEVE ANALYSIS PERCENT PASSING GRAM RETAINED	PERCENT RETAINED	PERCENT PASSING	TARGET GRADATION	SPEC LOW LIMIT	SPEC HIGH LIMIT
ASPHALT CONCRETE RESULTS						
% AC IN MIX BY NUCLEAR GAUGE				6.960		
% AC INTENDED				6.400		
SPECIFIC GRAVITY				2.390		
LAB DENSITY (50 BLOW-MARSHALL)				2.291		
SPECIFIC GRAVITY HIGH PRESSURE METER				2.372		
% VOIDS (50 BLOW-MARSHALL-RICE)				3.50		

COPIES TO:
CENTRAL LAB DIST. 4

IOWA DEPARTMENT OF TRANSPORTATION

ASSURANCE SAMPLE

OFFICE OF MATERIALS

Test Report - Miscellaneous Materials
Atlantic Laboratory

Material Asphalt Cores | County Mills

Intended Use Density Verification | Project No. SN-6058(1)--51-65

Laboratory No. | Design No.

Date Reported 11-8-89 | Contract No.

Producer | Contractor Cessford

Source

Unit of Material (7) Asphalt Cores | Subcontractor

Sampled By | Senders No. | Date 9-19-89

Station							
Dist. CL							
Thickness							

Technician Results

W 1	1947.0	1022.0	1295.0	1262.0	2171.0	2520.0	2020.0
W 3	1949.0	1024.0	1296.6	1263.0	2172.5	2523.0	2022.0
W 2	1071.5	578.0	715.5	703.5	1207.5	1413.0	1116.0
Diff.	877.5	446.0	580.5	559.5	965.0	1110.0	906.0
Density	2.219	2.291	2.231	2.256	2.250	2.270	2.230
Air Void							

Lab Density | Rice S.P.G.

District Lab. Results

W 1	1944.5	1022.0	1294.5	1261.5	2169.5	2519.0	2017.5
W 3	1946.0	1023.6	1295.0	1262.0	2170.5	2520.0	2018.5
W 2	1068.5	577.0	715.0	701.0	1204.0	1409.0	1113.5
Diff.	877.5	446.0	580.0	561.0	966.5	1111.0	905.0
Density	2.216	2.291	2.232	2.249	2.245	2.267	2.229

REMARKS: Surface

Signed Joe Osborn

Iowa Department of Transportation

DAILY PLANT REPORT

BITUMINOUS TREATED BASE, ASPHALT TREATED BASE, ASPHALT CONCRETE

County Mills 85
Project SN-6058(0)-565
Contract No.
Date 9-15-89
Report No. 1

Contractor Cessford Const Plant Location Highway 34
Plant Type Cedarapids Make Drum Pollution Equipment — Resident Engineer Tim Ebmeier
Mix Type B Class Surface Size 1½" Crushed Aggr. Sources Schildberg, Silver City Recycle Source NA
Asphalt Source & Grade Koch Omaha AC-10 Sand Sources Hallett Oakland Plant Operated 7:30 A.M. to 6:45 P.M. Mix No. ABD9-4001

SIEVE ANALYSIS OF COMBINED AGGREGATES

SAMPLE			SIEVE NO. - % PASSING												
JOB MIX FORMULA - LIMITS					100	92/100	82/70	62/77	44/58		17/27			2-7/8	AC-10A Hot Mix
Spl. ID	Time	Compl.	1½	1	¾	½	⅜	4	8	16	30	50	100	200	
FIA	1:00	yes			100	99	88	67	51	38	25	13	6.0	5.2	

SAMPLES SUBMITTED		SAMPLES SUBMITTED	
Materials	Senders No.	Materials	Senders No.
AC-10A Hot Mix	AC-10A HMIA		

Intended Added ____ % A.C.
Intended Total 6.40 % A.C. Tank Meas. 6.48 % A.C.

LAB. DEN. 2.290 **DENSITY RECORD** SOLID DEN. 2.362

Course Laid	Station	¢ Refer	Date Laid	*(1)	Density	% Density	% Voids
Binder	24+00	5'L	9-15-89	3½	2.236	97.642	5.33
"	37+20	8'L	9-15-89	4½	2.262	98.777	4.23
"	42+40	3'L	9-15-89	3¾	2.252	97.904	5.08
"	47+00	7'L	9-15-89	5	2.256	98.477	4.53
"	51+20	4'L	9-15-89	4	2.272	99.214	3.81
"	57+35	7'L	9-15-89	3⅝	2.262	98.777	4.23
"	63+09	3'L	9-15-89	4	2.314	101.048	2.03

TEMPERATURE RECORD

Time	7	9	11	1	3	5
Air				60	67	70
A.C.				290	290	285
Aggr.						
Mix				290	290	290
Mat						

MATERIALS DELIVERIES

Type	Ticket No.	Quantity
AC-10	252	6186
AC-10	392	6054
AC-10	389	6019
AC-10	406	5986
AC-10	293	6207
AC-10	410	6203

RECYCLED MIX ONLY

Total RAP Used Tons
Total Aggr. Used Tons
RAP Used %
Aggr. Used %

Avg. Field Density Lot #1 98.833-2.263
Avg. Field Density Lot #2

Fines/Bitumen Ratio = 0.80
Ave. % Field Voids = 4.18
Lab % Voids = 3.0
Q.I. (Density) = 3.60
(Show Calculation)

PRODUCTION AND PLACEMENT RECORD

*(2)	Side	Course Laid	From Station to Station	Tons Today	Tons To Date
3½	L	Binder	64+04.66 22+60	~~2.065~~ 1,032.92	1,032.92
		Sprinkle			

1	¾	½	⅜	4	8	16	30	50	100	200

COMMENTS

$$QI = \frac{98.833 - 95.000}{1.064}$$

COMMENTS: Delays, Breakdowns, Corrective Action, etc.
*Thickness: (1) Actual, (2) Intended
Bituminous Treated Base: Enter % Moisture in % Voids Column

Signed Gary L Schoenrock #115
Inspector Cert. No.

MATERIALS OFFICE -- RECORDS COPY

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Form 820007 11/87 H-1789

Iowa Department of Transportation

OCT 3 1989

County Mills BJ
Project SN-6058(1)-5-65
Contract No.
Date 9-18-89
Report No. 2

DAILY PLANT REPORT

BITUMINOUS TREATED BASE, ASPHALT TREATED BASE, ASPHALT CONCRETE

Contractor Cessford Const. Plant Location Highway 34
Plant Type Drum Make Cedarapids Pollution Equipment Resident Engineer Jim Ebmeier
Mix Type B Class Surface Size 1/2" Crushed Aggr. Sources Schildberg Silver City Recycle Source NA
Asphalt Source & Grade Koch Omaha AC10 Sand Sources Hallett Oakland Plant Operated 7:00 A.M. to 6:45 P.M. Mix No. ABDI-4001

SIEVE ANALYSIS OF COMBINED AGGREGATES

SAMPLE			SIEVE NO. - % PASSING												
JOB MIX FORMULA - LIMITS					100	92/100	83/97	63/77	46/58		19/27				2-7/8-7
Spl. ID	Time	Compl.	1½	1	¾	½	⅜	4	8	16	30	50	100	200
CFZA	7:30	Yes			100	100	89	69	53	41	27	13	7.5	6.6

SAMPLES SUBMITTED

Materials	Senders No.
Hot Mix	HMIA
"	HMIB
AC10	AC1B
"	AC2A

SAMPLES SUBMITTED

Materials	Senders No.

Intended Added ____ % A.C.
Intended Total 6.40 % A.C. Tank Meas. 6.25 % A.C.

LAB. DEN. 2.289

DENSITY RECORD

SOLID DEN. 2.365

Course Laid	Station	¢ Refer	Date Laid	*(1)	Density	% Density	% Voids
Binder	16+00	7'L	9-18-89	2.235	3¼	97.641	5.50
"	21+40	5'R	"	2.242	3⅛	96.636	6.47
"	39+10	3'R	"	2.251	3⅜	98.340	4.82
"	51+30	8'R	"	2.231	3¼	97.466	5.66
"	65+80	6'R	"	2.268	3	99.082	4.10
"	74+35	5'R	"	2.269	3 3/16	99.126	4.06
"	90+80	8'R	"	2.223	2⅞	97.117	6.00

TEMPERATURE RECORD

Time	7	9	11	1	3	5
Air	56	62	70	78	84	79
A.C.	305	302	295	300	300	300
Aggr.						
Mix	320	305	280	290	285	290
Mat						

RECYCLED MIX ONLY

Total RAP Used Tons
Total Aggr. Used Tons
RAP Used %
Aggr. Used %

MATERIALS DELIVERIES

Type	Ticket No.	Quantity
AC10	447	5571
AC10	448	6263
AC10	441	6230
AC10	453	5602
AC10	457	6276
AC10	2335	6408
Hist.	5357	1000
½" Cl.	7546	2405
Sand	55744	2245

Avg. Field Density Lot #1 2.284
Avg. Field Density Lot #2

Fines/Bitumen Ratio = 1.06
Ave. % Field Voids = 5.23
Lab % Voids = 3.1
Q.I. (Density) = 3.00
(Show Calculation)

PRODUCTION AND PLACEMENT RECORD

*(2)	Side	Course Laid	From Station to Station	Tons Today	Tons To Date
3½	Lt	Binder	22+20 - 6+00		
3½	Rt	Binder	6+00 - 99+90	2187.40	3220.32
		Sprinkle			

1	¾	½	⅜	4	8	16	30	50	100	200

COMMENTS

$$QI = \frac{97.915 - 95.000}{0.970} = 3.00$$

COMMENTS: Delays, Breakdowns, Corrective Action, etc.
*Thickness: (1) Actual, (2) Intended
Bituminous Treated Base: Enter % Moisture in % Voids Column

Signed Gary L. Shoemaker Cert. No.
Inspector

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Dep ner Trai rta

OCT 3 1989

DAILY PLANT REPORT

BITUMINOUS TREATED BASE, ASPHALT TREATED BASE, ASPHALT CONCRETE

Yuba BJ

County Yuba
Project SN-6058(1)--51.65
Contract No.
Date 9-19-89
Report No. 3

Contractor Cessford Const. Plant Location Highway 34
Plant Type Drum Make Cedarapids Pollution Equipment Baghouse Resident Engineer Jim Ebmeier
Mix Type B Class Surface Size ½" Crushed Aggr. Sources Schildberg Silver City Recycle Source NA
Asphalt Source & Grade Koch AC 10 Sand Sources Hallett Oakland Plant Operated 6:40 A.M. to 6:36 P.M. Mix No. ABD9-4001

SIEVE ANALYSIS OF COMBINED AGGREGATES

SAMPLE			SIEVE NO. - % PASSING											
JOB MIX FORMULA - LIMITS					100	90/100	76/77	63/77	46/58		20/30			2/8/7
Spl. ID	Time	Compl.	1½	1	¾	½	⅜	4	8	16	30	50	100	200
CF3A	7:30	yes			100	99	88	68	51	39	26	12	7.1	6.3
Assurance					100	98	89	70	54	42	28	13	7.7	6.7

SAMPLES SUBMITTED

Materials	Senders No.
Cores	
Mix	HM3A
"	HM2B
"	HM2C

SAMPLES SUBMITTED

Materials	Senders No.
AC10	AC2B
"	AC2C
"	AC2D

Intended Added % A.C.
Intended Total 6.40 % A.C. Tank Meas. 6.33 % A.C.

DENSITY RECORD

LAB. DEN. 2.295 SOLID DEN. 2.375

Course Laid	Station	¢ Refer	Date Laid	* (1)	Density	% Density	% Voids
Surface	3+20	4'R	9-19-89	3	2.219	96.688	6.57
Surface	19+10	6'R	9-19-89	1½	2.281	99.826	3.54
Surface	43+90	5'R	9-19-89	2	2.231	97.211	6.06
Surface	51+20	7'R	9-19-89	1⅞	2.256	98.301	5.01
Binder	66+30	8'L	9-19-89	3¼	2.250	98.039	5.26
Binder	77+50	3'L	9-19-89	3⅞	2.270	98.911	4.42
Binder	89+00	7'L	9-19-89	3⅞	2.230	97.168	6.11

TEMPERATURE RECORD

Time	7	9	11	1	3	5
Air	54	60	68	78	78	80
A.C.	300	300	300	300	300	300
Aggr.						
Mix	310	300	300	295	285	300
Mat						

MATERIALS DELIVERIES

Type	Ticket No.	Quantity
CSSIH	2173	4002
Sand	7497	714
RCI	7815	185

RECYCLED MIX ONLY

Total RAP Used Tons
Total Aggr. Used Tons
RAP Used %
Aggr. Used %

Avg. Field Density Lot #1: 2.250 5.26
Avg. Field Density Lot #2

Fines/Bitumen Ratio = 0.98
Ave. % Field Voids = 5.28
Lab % Voids = 3.3 3.07
Q.I. (Density) = 3.02
(Show Calculation)

PRODUCTION AND PLACEMENT RECORD

* (2)	Side	Course Laid	From Station to Station	Tons Today	Tons To Date
3½	Lt	Binder	64+20 - 101+90	739.8	3960.12
1½	Rt	Surface	0+00 - 64+20	929.98	929.98
1½	Lt	Surface	0+00 - 2+20		
		Sprinkle			

1	¾	½	⅜	4	8	16	30	50	100	200

COMMENTS

98.020 - 95.000 / 1.102 = 3.02

COMMENTS: Delays, Breakdowns, Corrective Action, etc.
*Thickness: (1) Actual, (2) Intended
Bituminous Treated Base: Enter % Moisture in % Voids Column

Signed Gary L. Koenrack Inspector 115 Cert. No.

MATERIALS OFFICE-RECORDS CENTER COPY

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Form 820007 11/87 H-1188

Iowa Department of Transportation

DAILY PLANT REPORT

BITUMINOUS TREATED BASE, ASPHALT TREATED BASE, ASPHALT CONCRETE

County Hills
Project SN-6058(1)--57-65
Contract No.
Date 9-20-89
Report No. 4

Contractor Cessford Const. Plant Location Highway 34
Plant Type Drum Make Cedarapids Pollution Equipment Baghouse Resident Engineer Jim Ebmeier
Mix Type B Class Surface Size 12" Crushed Aggr. Sources Schildberg Silver City Recycle Source NA
Asphalt Source & Grade Koch AC 10 Sand Sources Hallett Oakland Plant Operated 7:10 A.M. to 5:30 P.M. Mix No. ABDP-4001

SIEVE ANALYSIS OF COMBINED AGGREGATES

SAMPLE			SIEVE NO. - % PASSING											
JOB MIX FORMULA - LIMITS					100	99/100	83/97	63/77	44/58		24/30			2.1/8.7
Spl. ID	Time	Compl.	1½	1	¾	½	⅜	4	8	16	30	50	100	200
CF-4A	7:35				100	99	90	69	53	40	26	12	6.8	6.0

SAMPLES SUBMITTED

Materials	Senders No.
AC 10	AC-3A
"	AC-3B
"	AC-3C
"	AC-4A
Cores	

SAMPLES SUBMITTED

Materials	Senders No.
Mix	HM-4A
"	HM-3B
"	HM-3C

Intended Added ____ % A.C.
Intended Total 6.40 % A.C. Tank Meas. 6.52 % A.C.

LAB. DEN. 2.291 SOLID DEN. 2.372

DENSITY RECORD

Course Laid	Station	¢ Refer	Date Laid	*(1) Thickness	Density	% Density	% Voids
Surface	1+50	7L	9-20-89	1 3/8	2.249	98.167	5.14
"	43+70	4L	"	1 1/4	2.173	94.849	8.43
"	62+10	6L	"	1 3/4	2.218	96.819	6.49
"	67+00	7L	"	1 3/4	2.194	95.941	7.50
"	71+00	6R	"	2"	2.230	97.337	5.99
"	84+20	7L	"	1 3/4	2.215	96.683	6.62
"	91+40	3R	"	1 7/8	2.202	96.115	7.17

TEMPERATURE RECORD

Time	7	9	11	1	3	5
Air	54	62	69	80	80	
A.C.	300	300	285	290	295	
Aggr.						
Mix	300	295	300	300	300	
Mat						

RECYCLED MIX ONLY

Total RAP Used Tons
Total Aggr. Used Tons
RAP Used %
Aggr. Used %

MATERIALS DELIVERIES

Type	Ticket No.	Quantity
AC10	462	6397
AC10	473	6301
AC10	468	6140
AC10	3369	6348
AC10	484	6158
AC10	494	3357

Avg. Field Density Lot #1 2.212
Avg. Field Density Lot #2
Fines/Bitumen Ratio = .92
Ave. % Field Voids = 6.76
Lab % Voids = 3.5 3.91
Q.I. (Density) = 1.466
(Show Calculation)

PRODUCTION AND PLACEMENT RECORD

*(2) Thickness	Side	Course Laid	From Station to Station	Tons Today	Tons To Date
1 3/4	L	Surface	2+20 - 101+01	1583.73	2513.71
1 3/4	R	Surface	101+01 - 64+20		
		Sprinkle			

1	¾	½	⅜	4	8	16	30	50	100	200

COMMENTS

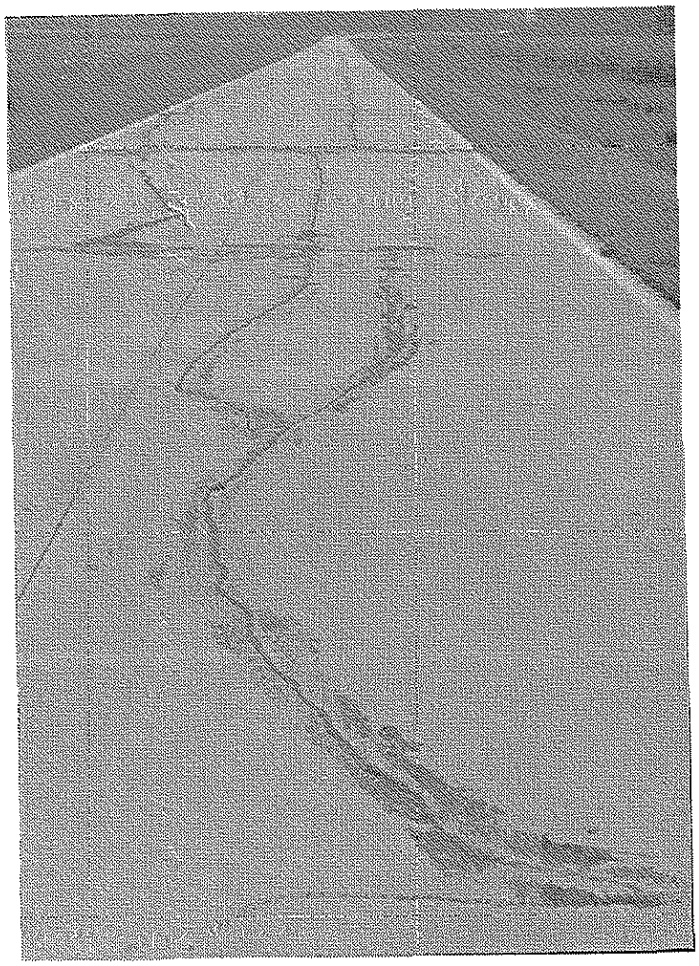
$$QT = \frac{96.558 - 95.000}{1.063} = 1.466$$

COMMENTS: Delays, Breakdowns, Corrective Action, etc.
*Thickness: (1) Actual, (2) Intended
Bituminous Treated Base: Enter % Moisture in % Voids Column

Signed Gary Schoenrock #115
Inspector Cert. No.

TER... OF ...E-RE... DS ... ER

Appendix E
Photos

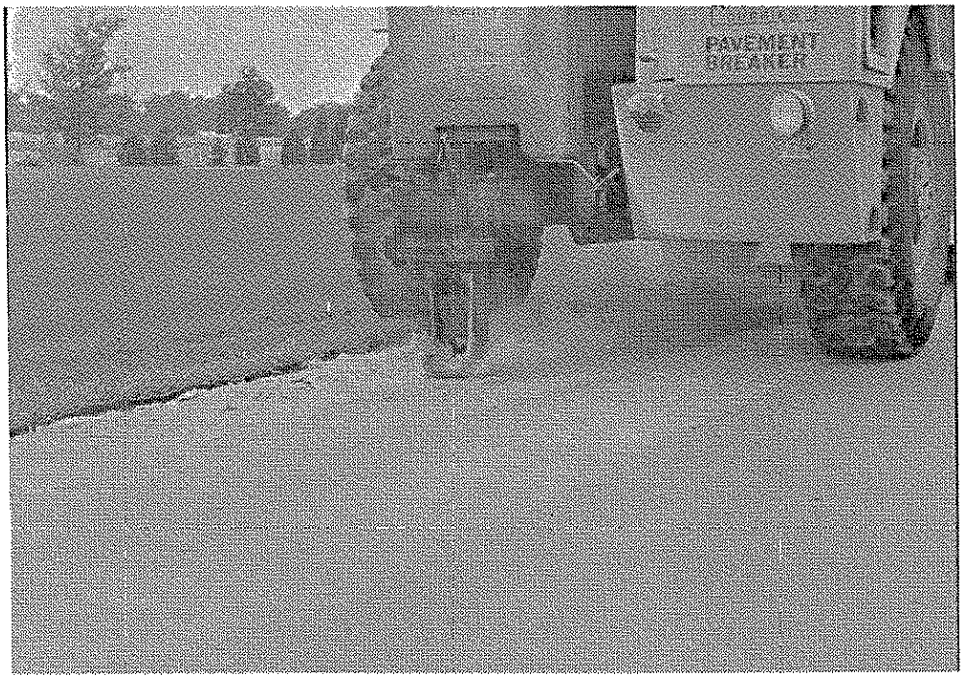


Typical Longitudinal Cracking

Load Related Pavement Failure

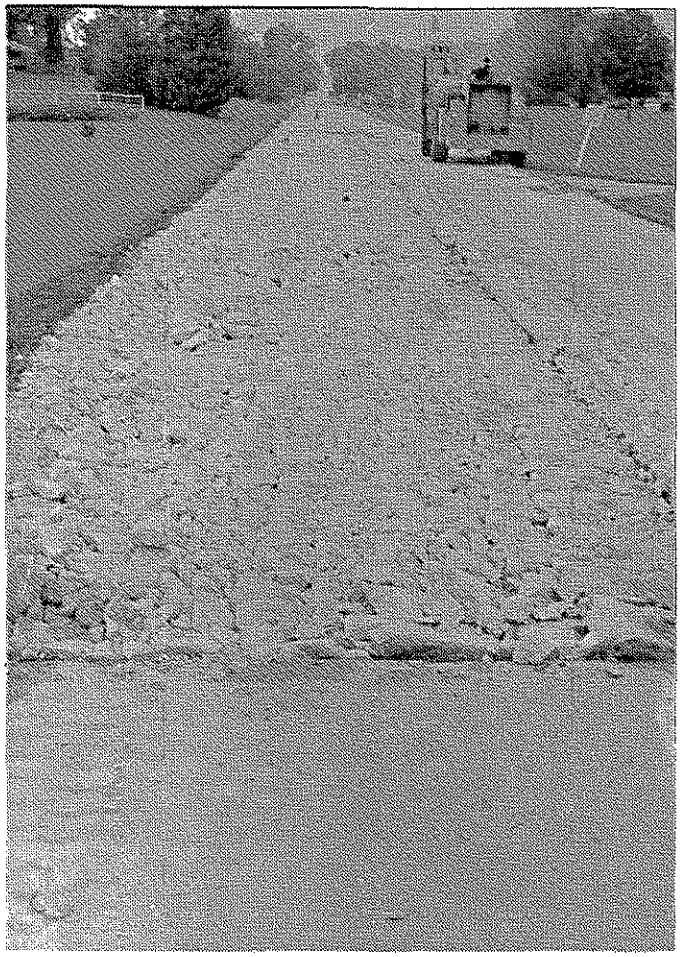
Complete Joint Failure

PB4 Pavement Breaker



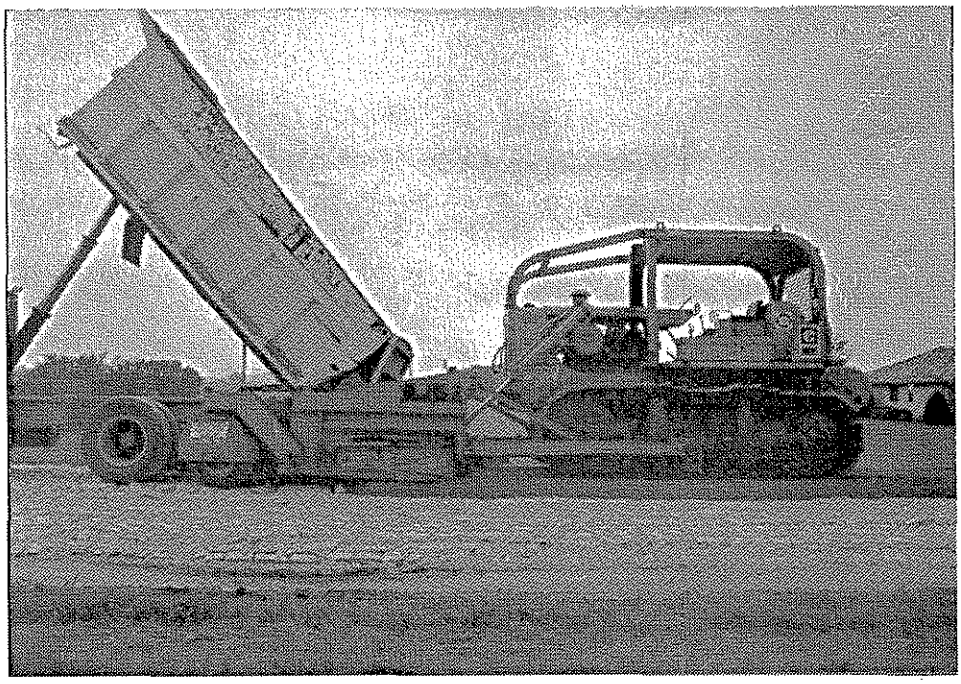
PB4 Pavement Breaker in Operation

Impact Foot of PB4 Pavement Breaker

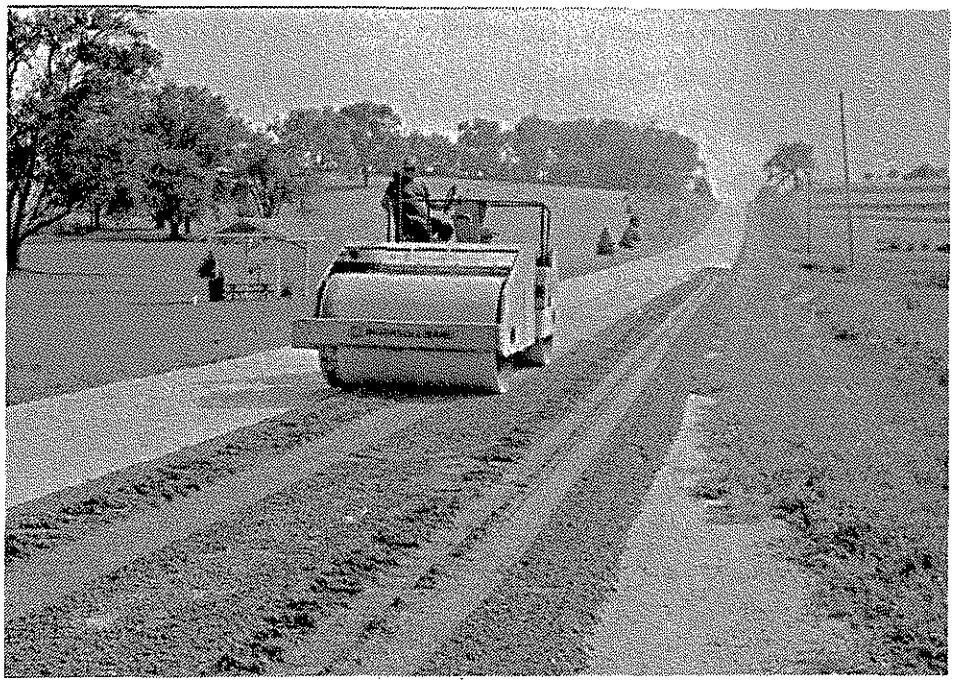


Rubblizing in Process

Rubblized Section of Pavement



Application of Choke Stone Using
"Jersey" Spreader



Compaction of Choke Stone